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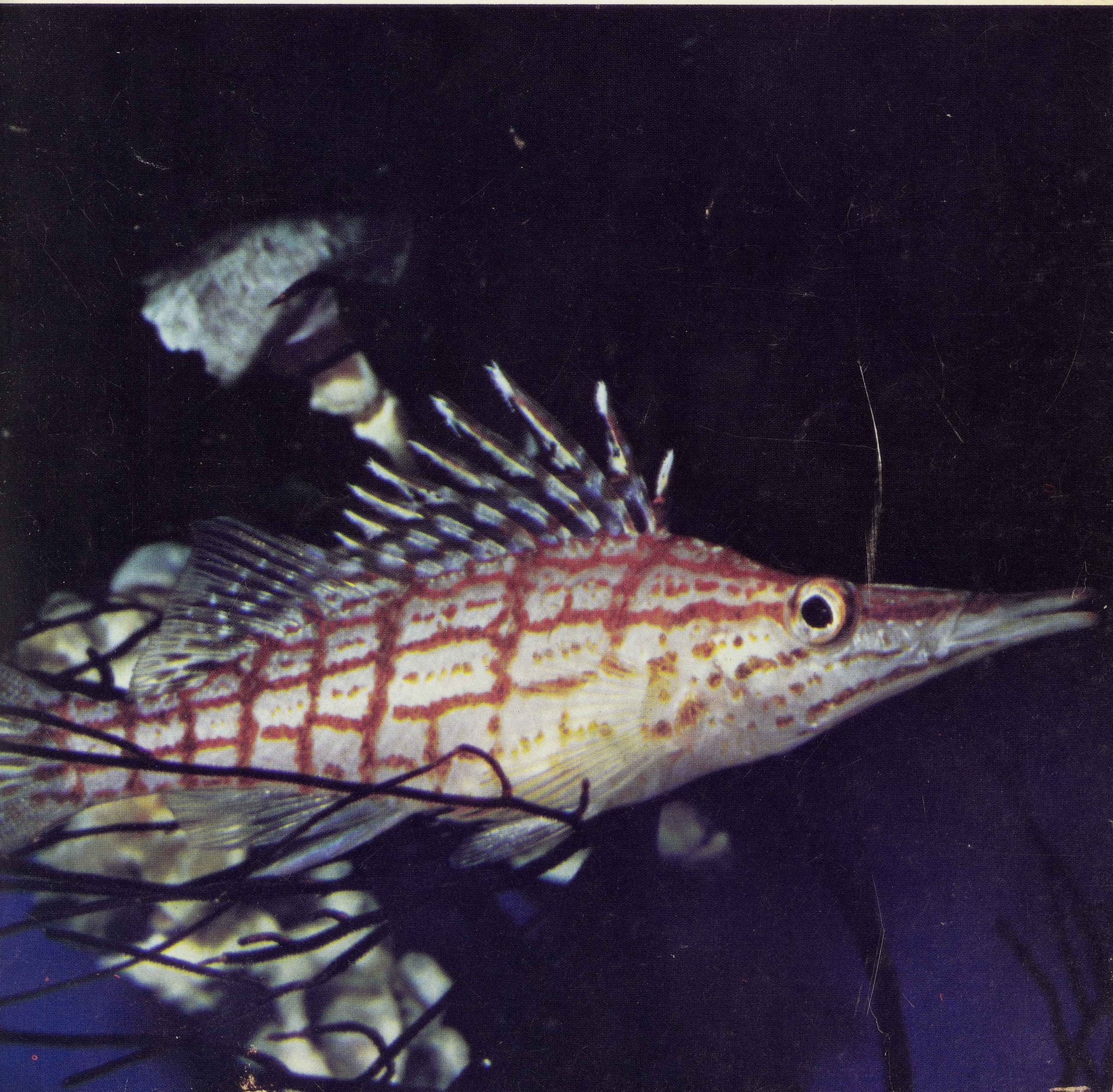

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MAGAZINE OF THE NEW YORK ZOOLOGICAL SOCIETY VOL. LXXIV, NO. 1 FEBRUARY, 1971

ABOUT THE COVER

Front: Longnose hawkfish *(Oxycirrhites typus).* First sighted in 1857 off the coast of Africa, the longnose hawkfish remains even today an exceptionally rare fish. The only living specimens of this fish presently on exhibit in the world are at the New York Aquarium. For more on this fish, from collection in the waters off Hawaii to exhibition at Coney Island, see page 2.

Back: Cook's treeboa *(Corallus enydris cookii)* of Tropical America is the most commonly seen treeboa; its color varies from almost solid yellow to grays, tans, and browns.

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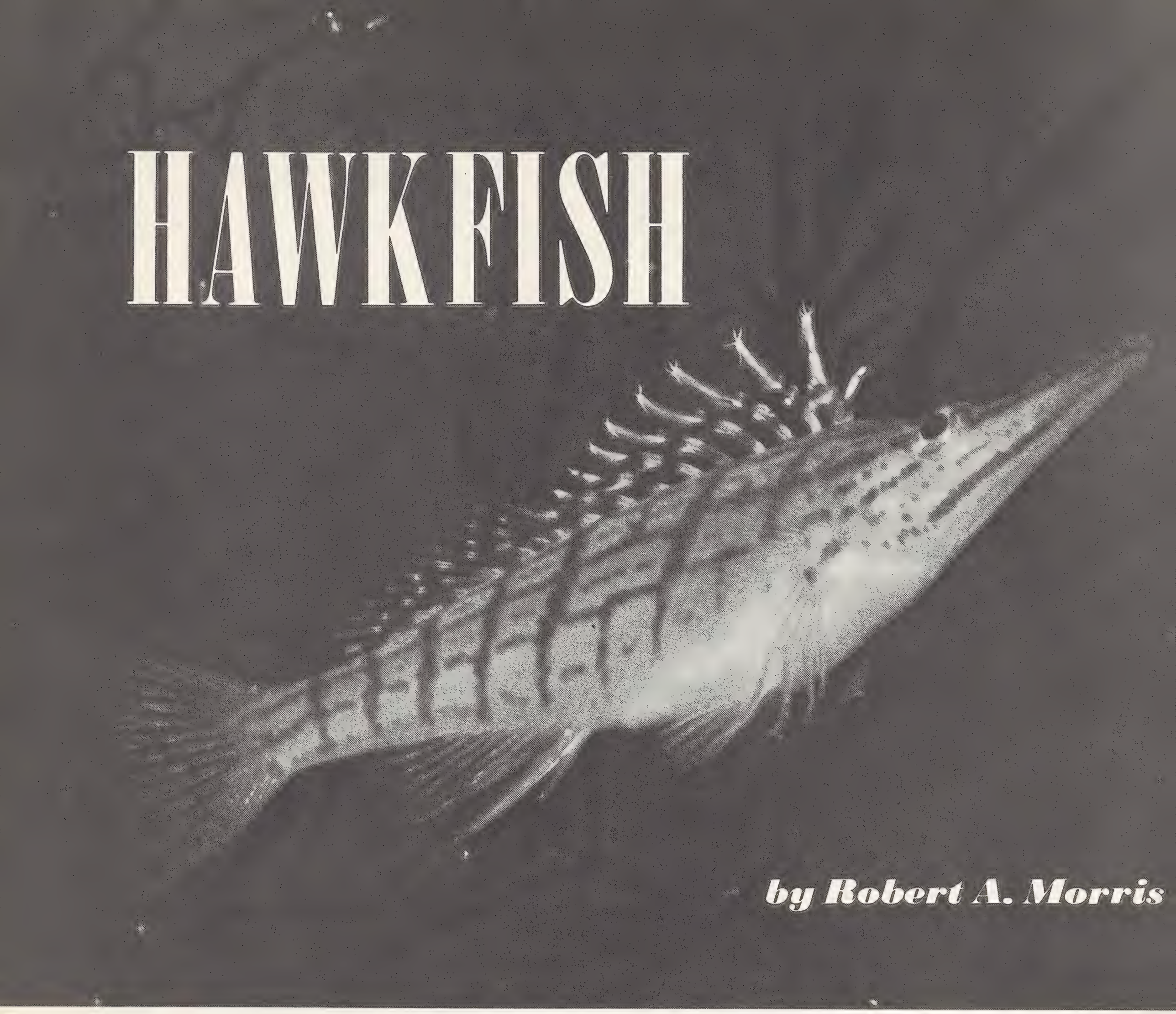
HAWKFISH



by Robert A. Morris

The longnose hawkfish at the New York Aquarium measure from four to four-and-one-half inches in length.

The boat appeared as a small speck 140 feet above us. The water was unusually clear, and the bottom flat and sandy with sporatic patches of coral and lava rock. My brother Don and I were exploring the deep depths off Diamond Head in Hawaii for new fish collecting areas.

We had found a fairly recent boat wreck; the bow section was intact, but the middle timbers were crumbling. Coral was beginning to grow over the sides. Large amberjacks, some reaching 40 pounds, swam in the distance. Many small reef fishes hovered about. We kept on the alert for sharks as they frequently abound in this type of area.

I started searching the bow section. Suddenly a small fish darted out. It had an unusually long nose and a dramatic checkerboard color pattern over its body. The fish rested on the bottom using its pectoral fins for support. I had never seen such a strange fish. I quickly signaled Don to take a look. The little fish darted in and out of the wreck, seemingly curious about the strange intruders. Its long nose resembled that of the longnose butterflyfish commonly seen on Hawaiian reefs. We studied the fish until our dwindling air supply forced us to surface.

After the dive we discussed the new fish. In 1000 hours of underwater exploration around the Hawaiian Islands, we had never seen a similar fish. A talk with Dr. William Gosline, noted ichthyologist at the University of Hawaii, revealed that it was probably a hawkfish of the family Cirrhitidae, and more than likely *Oxycirrhites,* a longnose hawkfish. Several had been spotted by other divers

in Hawaiian waters, but none had been collected. In fact, at that time, only four collected specimens had been reported in the entire world. One was dredged up in 1857 off Amboina, East Indies, one from Mauritius, one from the Philippines, and the last from Baja California in 1953. All specimens were collected in water deeper than 100 feet, indicating that the fish was a relatively deep-living creature. The widespread distribution of the longnose hawkfish was most unusual, and nothing was known of its natural history.

After learning that this might be an extremely rare fish, we made plans to capture the specimen for documentation of its existence in Hawaii. I purchased a miniature spear gun which looked much like a crossbow. Knowing that there was little time to collect a live specimen in 140 feet of water, we decided to settle for a dead one.

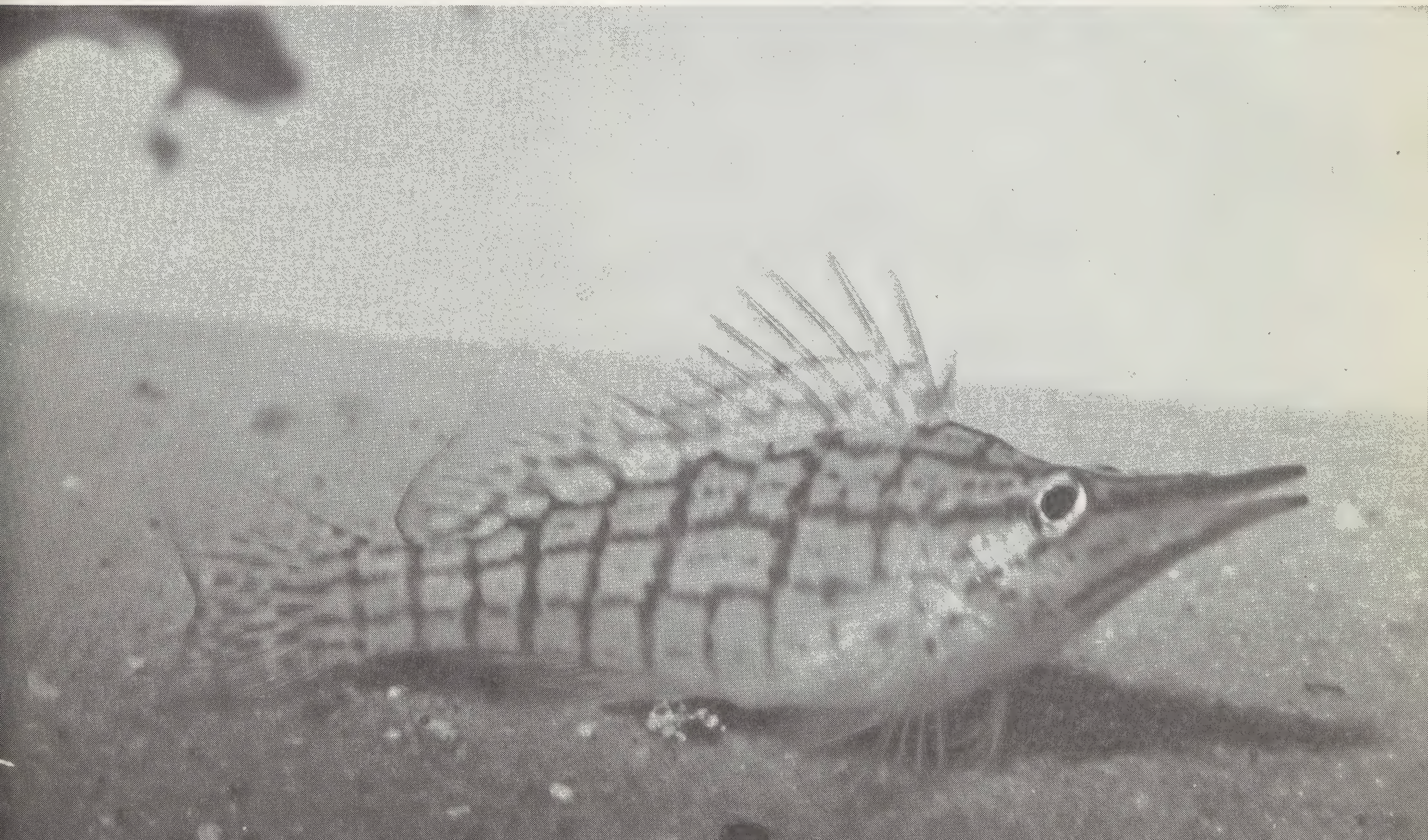
The next day we descended into the silent world. We dropped 100 feet, then 120, and finally settled to the bottom at 140 feet. It was only a short swim to the wreck. Anxiously we searched the bow section for our prize specimen. Suddenly, the little fish swam out and sat on the bottom in front of me. I took careful aim, fired, and missed. This procedure was repeated; each time the fish swam away and returned. By this time my brother was practically drowning with laughter. After returning to the surface minus the longnose hawkfish, I asked him what was so funny. Evidently, I had been under the influence of "rapture of the depths" caused by increased nitrogen absorption in the blood, a sensation similar to intoxication. Every time the fish moved, I would shoot. All the while I was positive that the fish was moving after I shot. Due to the deep depth, we abandoned our efforts to capture this rare fish.

Our first live capture of a hawkfish occurred in July 1961, when we were exploring a ledge in about 120 feet of water on the leeward side of Oahu, the main Hawaiian island. We collected two hawkfish that we found perched among the branches of a black coral. It is sometimes difficult to bring up fishes collected in very deep water. This is because many fishes that swim at varying depths have an organ called a gas bladder. This balloon-like structure allows the fish to swim with neutral bouyancy at any depth. By changing the volume of air in the bladder, the fish can adjust its density.

Fishes with gas bladders collected in depths greater than 40 feet tend to be distressed when brought to the surface. As depth – and water pressure – decreases, the bladder expands. If the ascent is too rapid, the fish is unable to rid itself of the expanding gases quickly enough. The pressure of the bladder on other organs or its rupture usually results in the death of the fish. (Sometimes collectors use a hypodermic needle to puncture the bladder to eliminate the problem.)

When we collected our first hawkfish we did

The hawkfish often "sits" on the bottom of the exhibit tank, resting on its pectoral fins.



not know if the species had a gas bladder. We ascended slowly, not knowing whether or not we would lose our fish. As we neared the boat, the fish appeared in excellent shape. There was little indication of the presence of a gas bladder. Shortly afterward, at home, we put the two fish in an aquarium and examined them. Pale reddish lines formed a checkerboard pattern over the white background color of each fish. We kept the fish for several days, but finally decided to preserve the specimens before they died or jumped out of the tank. Decomposed specimens would be of little use for positive identification. With great reluctance, we preserved both fish and donated them to the Bernice Bishop Museum in Hawaii.

The genus *Oxycirrhites* originally had been divided into three separate species; *Oxycirrhites typus,* from Amboina, East Indies; *O. seftoni,* from Baja California; and *O. morrisi* from the Philippines (not named after the author). The species were so classified because of slightly different color patterns, varying ray counts, and slightly different body proportions. A later revision in classification of the hawkfish family placed all of the longnose hawkfish in the single species *Oxycirrhites typus.* It was felt that the variations in body proportions, fin counts, and color patterns were normal species variations.

During subsequent dives in Hawaii, my brother and I spotted more of these rare fish. They were always found in pairs, usually resting in black coral trees in water over 100 feet in depth.

In March 1970, as curator of the New York Aquarium, I received a telegram from my brother in Hawaii stating that he had captured a pair of longnose hawkfish – was I interested in them for the aquarium? We hurriedly prepared a 100-gallon-tank at the aquarium for the new arrivals. A black coral tree from my collection of shells and corals was used as part of the tank decoration. Hopefully it would provide a natural habitat for the fish and make them feel at home. The next day the fish arrived; one was in excellent shape, but the other was very weak. The weak one died within a few hours and was given to the American Museum of Natural History. The surviving fish took up resident in the black coral tree after several days of exploring the tank. Not knowing the natural prey of the longnose hawkfish, we first tried to feed our specimen the live brine shrimp *Artemia.* These small one-quarter-inch "water fleas" were refused by the fish. We next tried the larger one-inch grass shrimp *Palaemonetes vulgaris.* The hawkfish immediately grabbed the shrimp, broke it in half with its long beak, and ate both halves. Weeks later the fish accepted the live brine shrimp, but seemed to prefer the grass shrimp.

Ours was the first known specimen of longnose hawkfish ever exhibited publicly. Here was a fish extremely rare in collections. Certainly the coelacanth, thought extinct for 60 million years but discovered alive in 1938, is rare, but to date approximately 50 specimens have been collected. To my knowledge, however, only 17 *Oxycirrhites* have been collected to date, and its distribution spans the Pacific.

Much to my surprise, about a week after our first hawkfish shipment, I received a call from my brother saying he had spotted another pair of hawkfish in 120 feet of water. He collected these and shipped them to the aquarium. Both fish arrived in excellent condition, and we carefully placed them in the same tank with our first hawkfish. One of the new fish immediately settled in the branches of coral. The other was challenged by the old resident. These two fish immediately began a ritual that none of us had observed before. Both fish went around and around in mid-water, side by side, seemingly threatening each other. Each raised and lowered its dorsal fin numerous times. The circular swimming continued for several minutes. Finally, one of the fish grabbed the other by its elongate mouth and held fast. They continued swimming around the tank, one fish firmly attached to the snout of the other with bulldog tenacity. Fascinated, we watched for several minutes. The fish whose mouth was held shut by its opponent was having difficulty respiring because water-bearing oxygen normally flows through the mouth of the fish, over the gills, and out through the gill cavities. Most interspecies battles do not end in death of either opponent. Display, threat, and test of strength are commonly employed in this sort of battle. Perhaps, however, we were witnessing a real showdown to death. Not wishing to lose such a rare specimen, we removed one of the fish from the exhibit.

Observations of the longnose hawkfish in nature and also in captivity seem to confirm that they reside in pairs, probably one male and one female, and have an affinity for black coral growth either for protection or concealment. The battle we witnessed also confirms territorial behavior. This strange and beautiful fish is without a doubt one of the rarest and most interesting specimens exhibited by the New York Aquarium.

The Prairie Chicken

A Chance for Survival?

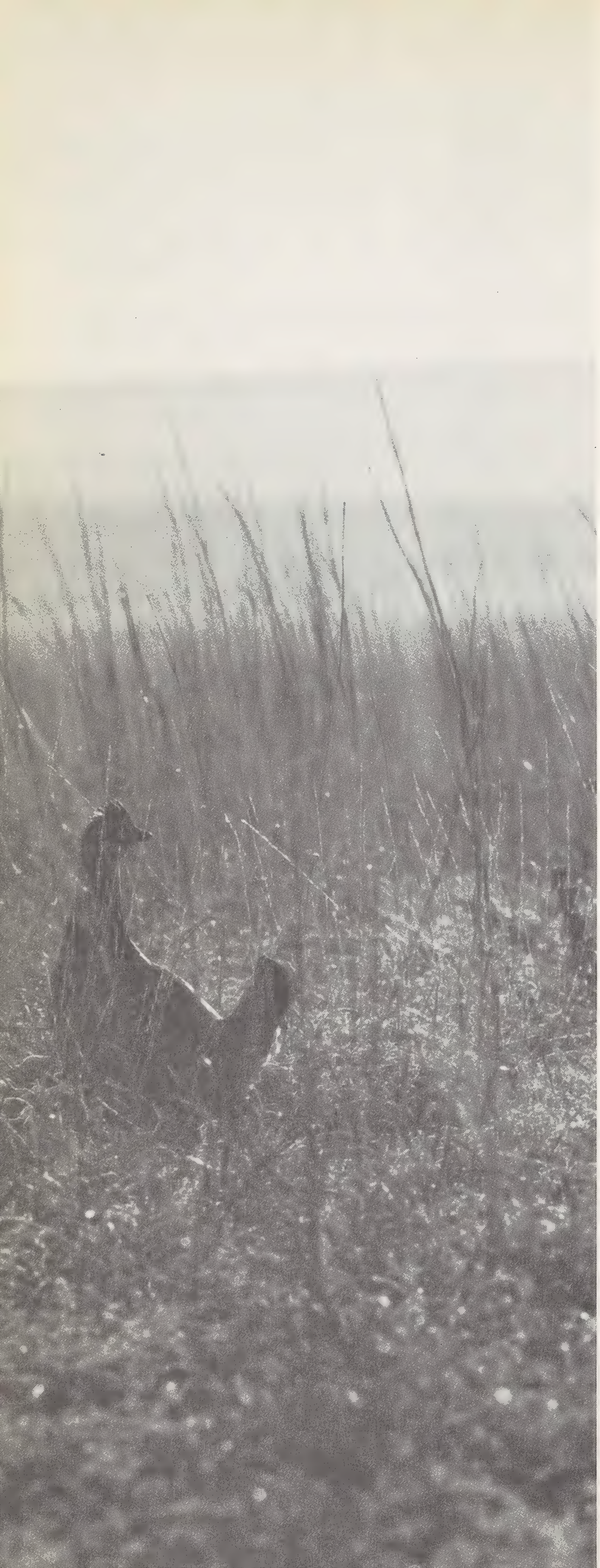
by Donald M. Christisen

The temperature was near freezing and a disagreeable chill wind blew out of the northeast, buffeting everything before it in the gray April dawn. Amid what seemed to be a desert of tilled land lay an oasis of grass. On this grassy island, feathered forms skittered about, occasionally leaping several feet into the air. The performers, watched from a bird blind by a game technician, were greater prairie chickens, eight of them – the only male members of their species in the entire state of Indiana.

Hundreds of miles to the north that same day, winter seemed to linger over the Wisconsin marshlands as wind-lashed sleet and snow pelted a flimsy bird blind. Inside, a pair of scientists watched as several yards away a group of greater prairie chickens bowed and danced in their courtship ritual. Most of the birds had been live-trapped and banded previously in an effort that has helped preserve about 500 greater prairie chickens in the Badger State.

On the same morning four excited members of the Audubon Society watched a group of 18 greater prairie chickens on a knoll in the tall-grass prairie of Missouri. Raindrops spattered on the

As the sign above says, the Taberville Prairie in Missouri is dedicated to the preservation of the prairie chicken. It is one of several areas that may provide a chance for survival of the species.



The greater prairie chicken requires permanent grass of sufficient quality and quantity to furnish protection.

birders' blind as they excitedly logged their first sight records of the greater prairie chicken. Those that the birders' watched were among the 7,000 members of their kind left in Missouri.

Meanwhile, in Oklahoma, wildlife management authorities engaged in a census of that state's greater prairie chickens were predicting a hunting season harvest of 15,000 birds. And in Kansas, the harvest would be several times that.

For the greater prairie chicken, actually a species of pinnated grouse, existence is measured in extremes. The species is endangered in some of the states in its range, and plentiful enough in others so that managed hunting is allowed. There is ever increasing concern that the greater prairie chicken could follow its relative, the heath hen, into extinction. The heath hen, a race of prairie chicken, inhabited parts of Connecticut, Massachusetts, New Jersey, New York, Pennsylvania, and probably other states of the Northeast before it died out 40 years ago. Another race, the Attwater's prairie chicken is on the federal endangered species list. This bird of the coastal prairies, gone from Louisiana, is clinging to survival in Texas. However it faces loss of suitable habitat. The habitat of the lesser prairie chicken of the short grass prairies of Texas, Oklahoma, Kansas, and New Mexico also is shrinking.

One only need study a map of north central United States and its borderlands to realize the extent of the indigenous range of the greater prairie chicken. Iowa, Kentucky, Ohio, Tennessee, and Arkansas no longer have chickens; Indiana's birds are on the verge of extinction and five other states are trying to maintain enough breeding stock to preserve this grouse, probably as a museum species.

The greater prairie chicken was able to adapt to the environment created by pioneer farming methods, but the land has changed since pioneer days. Anything which disturbs the permanency of grass affects the prairie chicken. The plow and the cow have been major offenders in the dispossession of the prairie chicken simply because the native grass either has been turned under or clipped off.

Loss of permanent grass of sufficient quality and quantity to furnish protection for the birds has been the major factor in the decline of the greater prairie chicken. This loss is attributed to

the conversion of grassland to tilled crops, encroachment of grassland by trees and shrubs, and removal of grass cover by grazing and haying. In the western portion of the range, additional factors add to the problem even where sufficient grass is present.

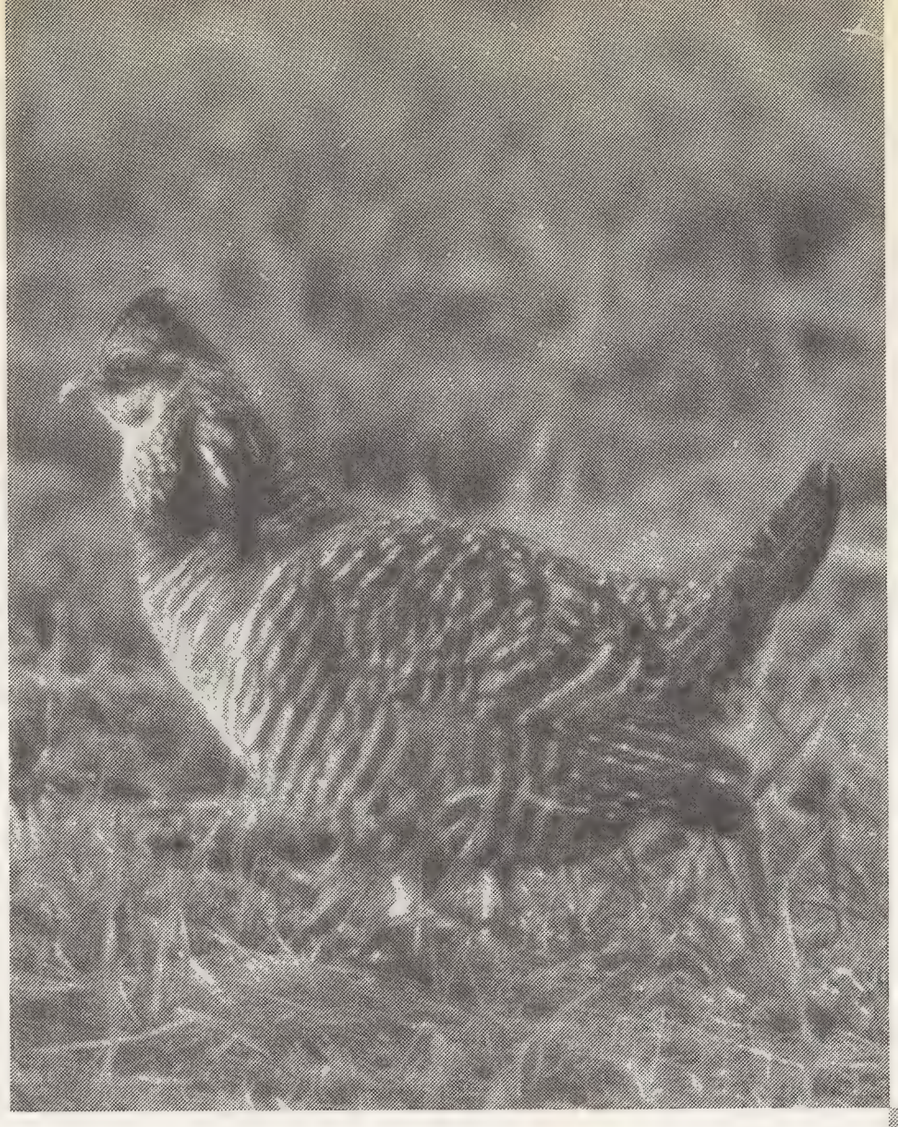
Until the 1880s, the prairie chicken actually had thrived with early settlement which created patches of grain and lightly-grazed prairies. Numbers of the prairie chicken reached an all time high in the millions about the period of the Civil War.

However, by 1900, market hunting and habitat destruction had taken their toll. Prairie chickens still were hunted in some states and dog trainers still worked their animals on the birds, but the market wagon boxes were empty. The boom in the slaughter of the prairie chicken for market was over and bust had arrived. The disappearance of the prairie chicken followed the westward march of settlement: Kentucky, Ohio, Indiana, Illinois, and Wisconsin. Only pocket remnants of birds remained in its wake. These remnants usually were found on the marginal portions of the habitat, rejected or unused by farmers because of low fertility. Sometimes, however, there were isolated instances of farsighted homesteaders who associated native prairies with the wild chickens and cared enough to preserve both.

Certainly the two-pound prairie chicken was a welcome meat dish on the settler's table. It took the place of the domestic chicken and added variety to the usual diet of cured meats and other wild game. However, there was something about this bird that set it apart from other living things in the lonely life of the settler. Each spring, as breeding began, male prairie chickens gathered in flocks to dance and sing away the early morning hours of the day; they would return in the late afternoon to resume the ritual of courtship. Their resonant *boom boom boomm-m* lasted throughout the planting months and on calm days could be heard over a mile away. The sound of several booming grounds became an incessant hum to one's ears, and the loneliest prairie settler had company all spring.

Fortunately, in the places where prairie

During the breeding season, male prairie chickens visit the "booming grounds." Each cock selects a small parcel of land and the space above it — a territory he defends against all other males.



In the courtship dance, the males stamp their feet rapidly in an audible patter. They bow low with outspread wings, distend and inflate the yellow-orange air sacs on each side of the neck, and emit a three-note mating call. At the end of the dance, the male remains motionless a few moments with wings outspread, and feathered tufts erect on each side of the head.

The hen walks through the booming grounds, seemingly uninterested in the commotion around her. Eventually, however, she selects a particular male and mating follows.

During a territorial dispute, feathers fly while the birds fill the air with cackling. Seldom, however, are the battlers injured.

When an unseen territorial boundary is crossed by another cock, a fight occurs, with combatants leaping several feet into the air.

chickens survive, people still can see this bird ritual. The males, mottled brown with black cross-barring and yellow-orange eyebrows, walk or glide into the courting grounds at day break. Usually each male selects some small parcel of land and the space above it, which he guards zealously from all other males by darting and maneuvering about, flogging those intruders that dare cross the unseen boundaries. Feathers sometime fly as combatants leap several feet into the air or girate about the grounds, to the accompaniment of squawks and cackles. Amidst the pandemonium, other males, if uninterrupted by intruders, stamp their feet rapidly in an audible patter, bow low with outspread wings, distend and inflate yellow-orange air sacs on each side of the neck, and emit a three-note love call. The termination of the dance is as picturesque and graceful as any ballet. The males remain motionless a few moments with wings outspread and pinnae (feathered tufts) erect on each side of the head. The hens, without the bright markings, visit the grounds independently, remaining a relatively short time with an air of disinterest in all the commotion. Mating occurs on the ground whenever a hen is receptive to a particular male.

By late spring most of the hens are nesting or bringing up broods and no longer visit the mating

grounds. The spirited dancing and booming wanes after early April, but sporadic performances may last into June. Again there is some limited activity on the grounds by the males in the fall. This characteristic of assemblage makes it easier for wild life agencies to estimate greater prairie chicken populations.

Grass of sufficient height to hide the hen is necessary for a successful nest. Nest sites include pastures, hayfields, fence rows, and sometimes small grain fields. About a dozen olive or tan colored eggs constitute a clutch; incubation requires about 23 days. Re-nesting seldom occurs if the first nest is broken up after incubation is well under way. The young chickens, tiny puffs of fluffy down, can leave the nest with the hen a few hours after hatching. The young birds are able to fly at three to four weeks of age, and at eight to ten weeks they are mature enough to leave the hen and form a flock.

Young birds depend on insects for food the first few weeks of life. Adults, too, take large quantities of insects when available but depend on wild plant seeds, waste grains such as corn, milo, and soybeans, as well as the green vegetation of legumes, and small grain.

As with many other game birds, the average life span is relatively short – about a year whether or not the bird is hunted. The quality of the environment has a greater impact on the welfare of the population than the single factor of hunting. However, at museum survival levels, the loss of one bird to any cause can be a catastrophe.

The states concerned with preserving the greater prairie chicken have been aware of the threat to its survival for more than two decades. In 1952, a National Committee on Prairie Chickens was formed with the sponsorship of the National Wildlife Federation. The function of this committee of 15 prominent leaders in wildlife conservation was twofold: to call the attention of the public and responsible government officials to the

Tail spread and pinnates extended, a cock cackles to attract the attention of a wandering female.

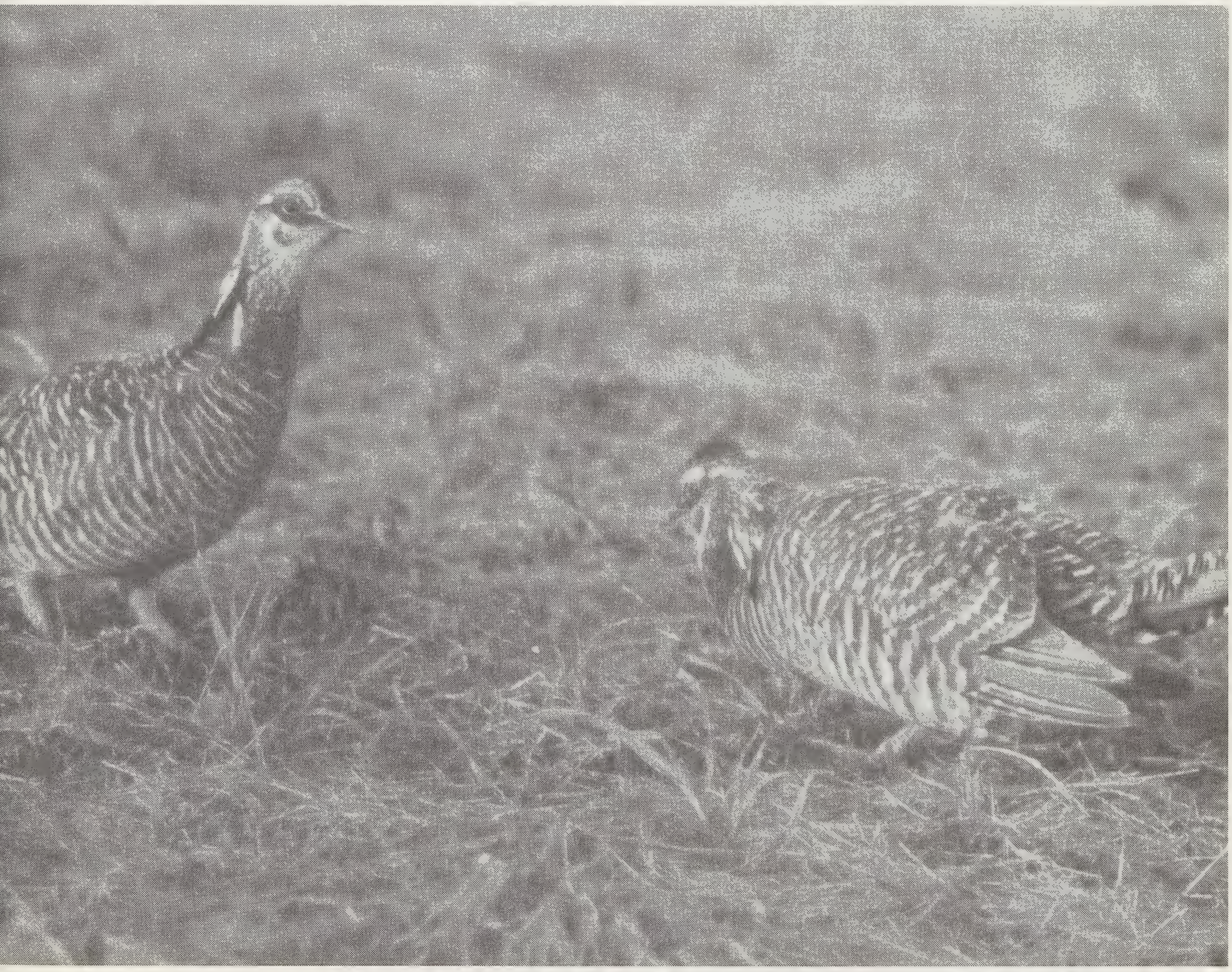
plight of the species, and to make recommendations for conserving and managing it as a valuable wildlife resource.

In brief, this national committee recommended the following measures:

(1) Preservation of the bird as a living museum species in those states where remnant flocks and foreseeable land-use patterns offer no hope for survival of large populations.
(2) Restoration and management as a game bird in states with the potential to maintain large numbers of birds.
(3) Provision of more funds by state game departments to prairie chicken research and acquisition of land.
(4) Legislation to make available to the states for wildlife purposes an unappropriated balance in the federal treasury under the Pittman-Robertson Act.
(5) Better coordination of research activities undertaken by the various states.
(6) Coordination of pinnated grouse and sharp-tail grouse research and management . . . where the two species overlap in range.
(7) Establishment of a grasslands national monument.
(8) Greater recognition of and attention to wildlife values by land-use agencies of federal and state governments.
(9) Educational and publicity campaigns stressing the rarity and value of the prairie chicken and its habitat requirements.

There has been a meaningful response to these recommendations. Research activities were strengthened and coordinated with the formation of the Prairie Grouse Technical Council in 1957. There has also been an increasing amount of publicity in several states about the plight of the prairie chicken.

Two cocks prepare to do battle over territorial rights on the booming ground.



Citizens groups in three states – Wisconsin, Illinois, and Indiana – are involved in land acquisition programs of benefit to the greater prairie chicken. Another state, North Dakota, has a program now past the planning stage.

The most successful program in terms of contributions and acreage acquired has been in Wisconsin. This success story began in 1954 when the Wisconsin Conservation League purchased 80 acres of habitat. By 1958, a number of efforts in Wisconsin were combined under the newly-organized Prairie Chicken Foundation. In 1960, a Milwaukee oriented group, the Society of Tympanuchus Cupido Pinnatus, Ltd. (the greater prairie chicken's scientific name is *Tympanuchus cupido pinnatus),* joined the effort to preserve the prairie chicken by acquiring land suitable for prairie chicken habitat. So far, over 10,000 acres have been acquired for the prairie chicken in Wisconsin.

The Prairie Chicken Foundation of Illinois was formed in 1959 to preserve the few remaining flocks in that state. Nearly 1,000 acres of land have been acquired for the birds. However, acquisition of a section of grassland in Indiana appears to have been a story of too little, if not too late. Only by restoration of suitable habitat and re-introduction can the birds dance again in Hoosierland. In Michigan, 436 acres are available for prairie chickens, which number about 200 for the entire state.

The corn and bean fields of Iowa are not fit for the prairie chicken. Once this land was mostly rolling native prairies with vast populations of chickens; now the chicken is gone. Minnesota hunters last hunted the prairie chicken in 1942 after long series of successful seasons. Only token numbers of the bird remain in that state.

Missouri, too, experienced a decline in the greater prairie chicken and attempted to change the trend as early as 1906 by closing the hunting season. But this in itself has been ineffective because the "open season" on habitat remained in effect. Fifteen million acres of native grass land were destroyed. About 7,000 birds remain, mostly in the southwest part of the state, where the native bluestem prairie still occurs. The attrition of prairies is severe, but hope remains that some flocks of the greater prairie chicken can be preserved in Missouri. In 1959, the Missouri Department of Conservation purchased two prairies totaling 1,765 acres specifically for prairie chickens, and an active management program is underway.

Additional help is coming from the newly-formed Missouri Prairie Foundation, whose objectives include the acquisition and preservation of native bluestem prairies. Since its organization in 1966, 300 acres of prairie have been purchased and other acreages are under consideration. Acquisition of lands for prairie chicken preservation is planned in North Dakota.

These are examples of lay groups and state agencies active in preserving flocks of prairie chickens for their respective states. In the restoration and management of the greater prairie chicken as a game bird, the Oklahoma Department of Wildlife Conservation has been most successful. Restored to the open season status about a decade ago, Oklahoma's population of greater prairie chickens has shown a remarkable recovery. Kansas, which tops all states in greater prairie chicken harvest and population, as well as Nebraska and South Dakota, support large populations and retain an open season.

Even in the states allowing hunting, however, prairie chickens no longer occur in the more fertile areas of their former range, but instead have been forced into the most marginal portions of the range. In general, the shift has been westward into a drier climate unfavorable for row crop farming and away from the moist tall grass prairie habitat.

All told, less than one-and-one-fourth million greater prairie chickens remain of the great mid-continent population that numbered in the millions.

In view of agricultural trends, the outlook for preserving the greater prairie chicken in some states appears grim, even though a few states have harvestable populations. Hopefully, populations of this bird can be maintained in most of these states for man to enjoy in the wild.

Beautiful in its own right, the bluestem grass prairie, if preserved, may also enable man to preserve the greater prairie chicken.

A GLIMPSE OF THE PAST

On November 8, 1899, Henry Fairfield Osborn, first president of the New York Zoological Society, officiated at the opening of the zoological park that was to become known as the Bronx Zoo.

In 1905, the New York Aquarium often sent "expeditions" to the zoo to restock the lakes or to seine specimens for the tanks downtown.

The New York Aquarium was originally located in Castle Clinton at Battery Park.

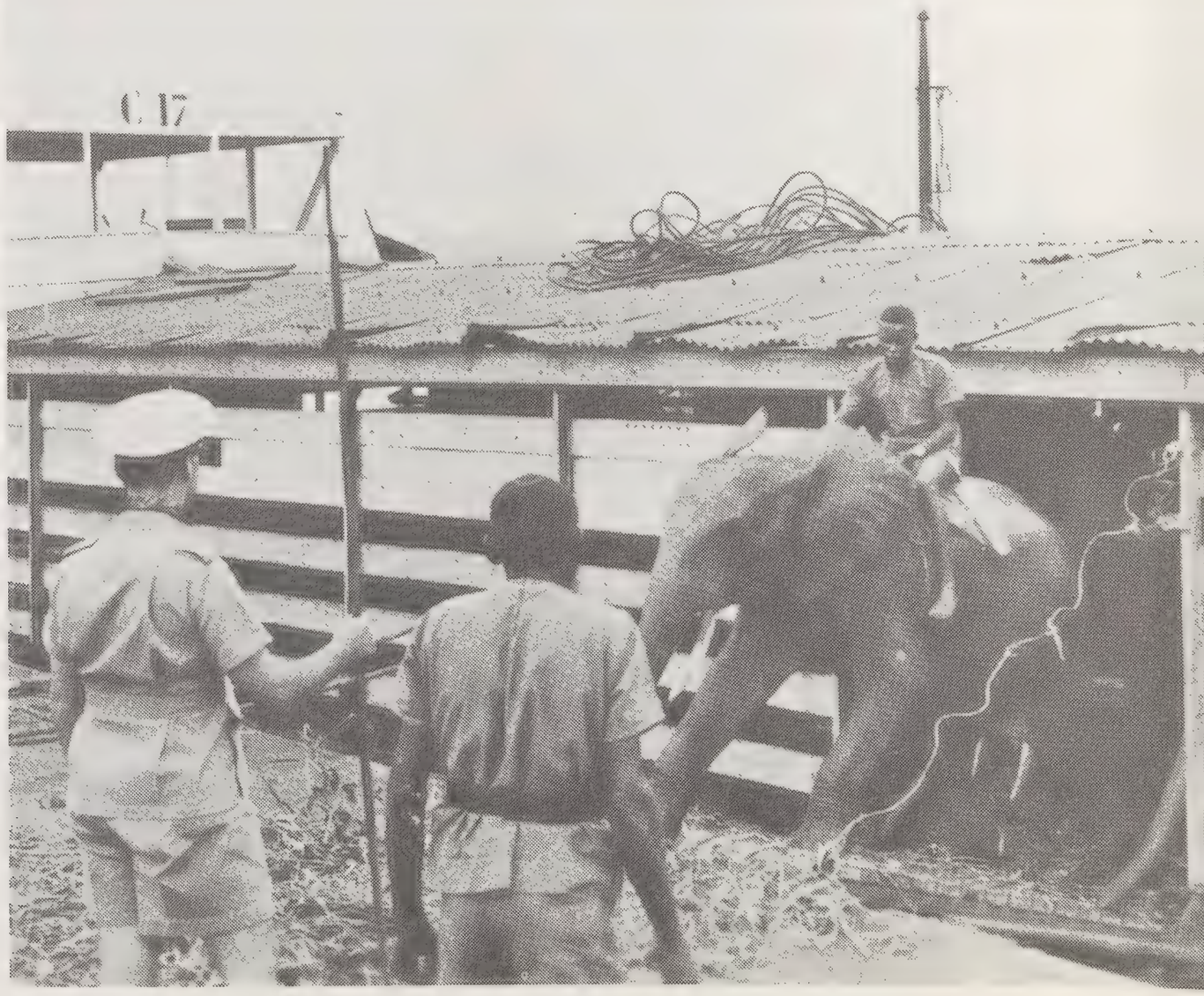
Members of the society eagerly inspected the old Bear Dens on opening day in 1899.

The Primate House opened just before Christmas in 1901. By 1903, more than a million people had already visited the zoo.

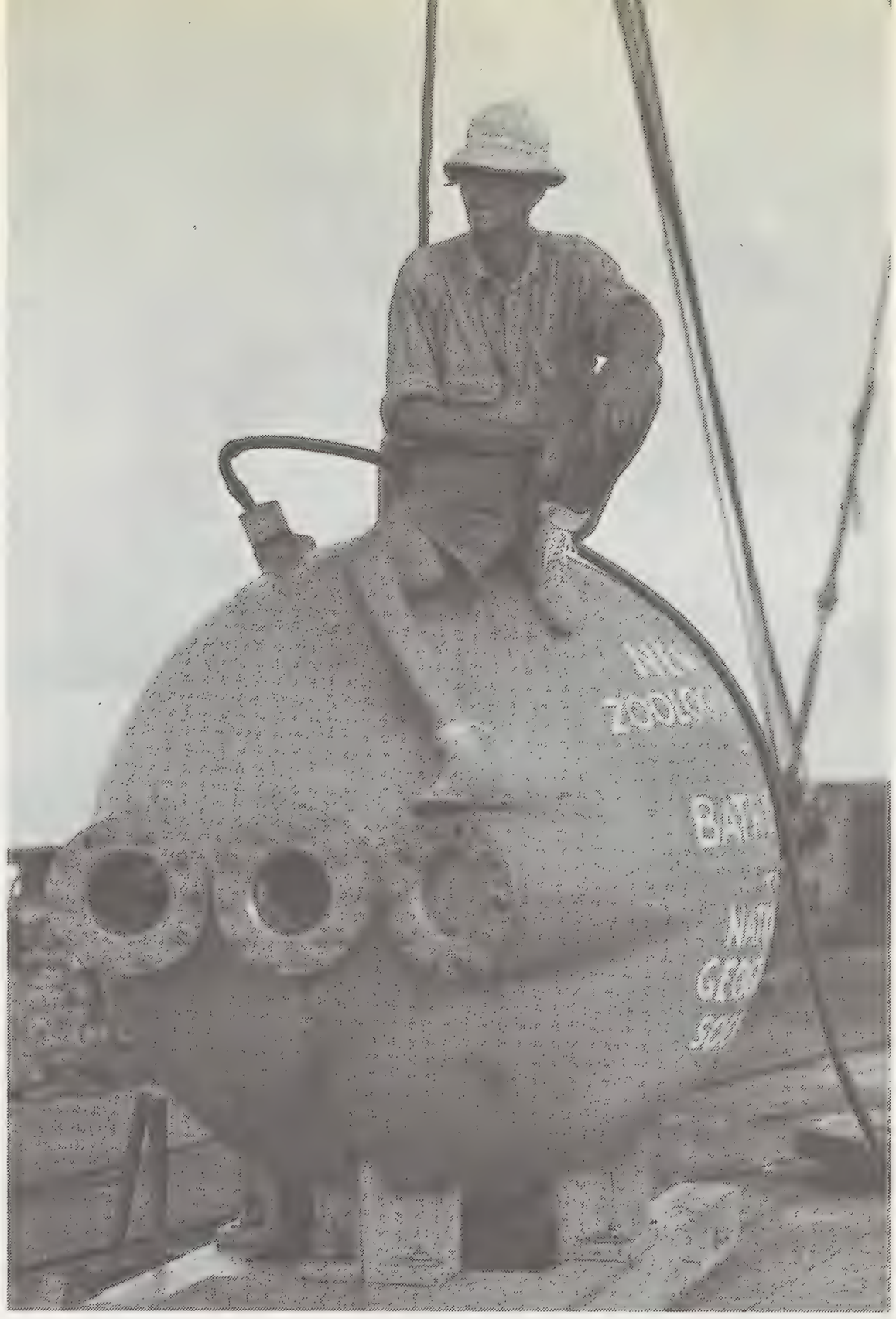
Zoological history was made in 1922 with the exhibition of a duck-billed platypus at the Bronx Zoo, the first time the animal ever was seen alive outside of Australia.

The zoo's first giant panda, Pandora, arrived as a baby in 1938. In all, four pandas have been exhibited over the years, one of which is shown in the specially-built Panda Moat.

The zoo did not receive its first elephant until 1904, when one was presented to the society by a member.



In 1934, William Beebe (at right) and Otis Barton climbed into the bathysphere, a hollow ball of steel, and descended deeper into the ocean depths than man had ever gone before — 3,028 feet.



In 1905, a nucleus herd of 15 American bison (commonly called buffalo) was sent from the zoo to the Wichita Forest Reserve in Oklahoma.

Manatees

by Bill Barada

A diver entering the cave at Crystal River Springs disturbs the school fish hovering near the surface of the clear waters.

Snorkeling on the surface of Crystal River Springs, Florida, I stared in fascination at the scene revealed by my face mask. In the clear water, a mixture of both marine and freshwater fishes swam about. A school of ocean-going crevalle jack flashed around me like a squadron of jet aircraft. Below them, slow moving garfish prowled the white limestone bottom, and through the aquatic vegetation, I caught glimpses of marine snapper and grouper, native bass and perch. A variety of marine creatures migrate up Crystal River during the winter months and among their numbers are the manatees.

The manatee and dugongs of the Indo-Pacific are members of the order Sirenia. Manatees inhabit the coasts of tropical and subtropical America and West Africa. They are slightly larger than dugongs, reaching lengths exceeding 13 feet, compared to the dugongs' maximum of 10 feet. The sirenians are so decimated in number they are threatened with extinction and so rare that, with the exception of a few places such as Crystal River, they are seldom seen.

The fossil remains of manatees do not appear in the prehistoric Indian mounds of Florida, which abound with the bones of mammoths, mastodons, saber-toothed cats, and other species of the Pleistocene. The earliest accounts of encounters with them appear in the New World exploration records of Christopher Columbus and Ponce de Leon. The dugong, although non-existent in Europe, is mentioned in Greek mythology and according to biblical legend, the Ark of the Covenant was shielded by the skin of a dugong.

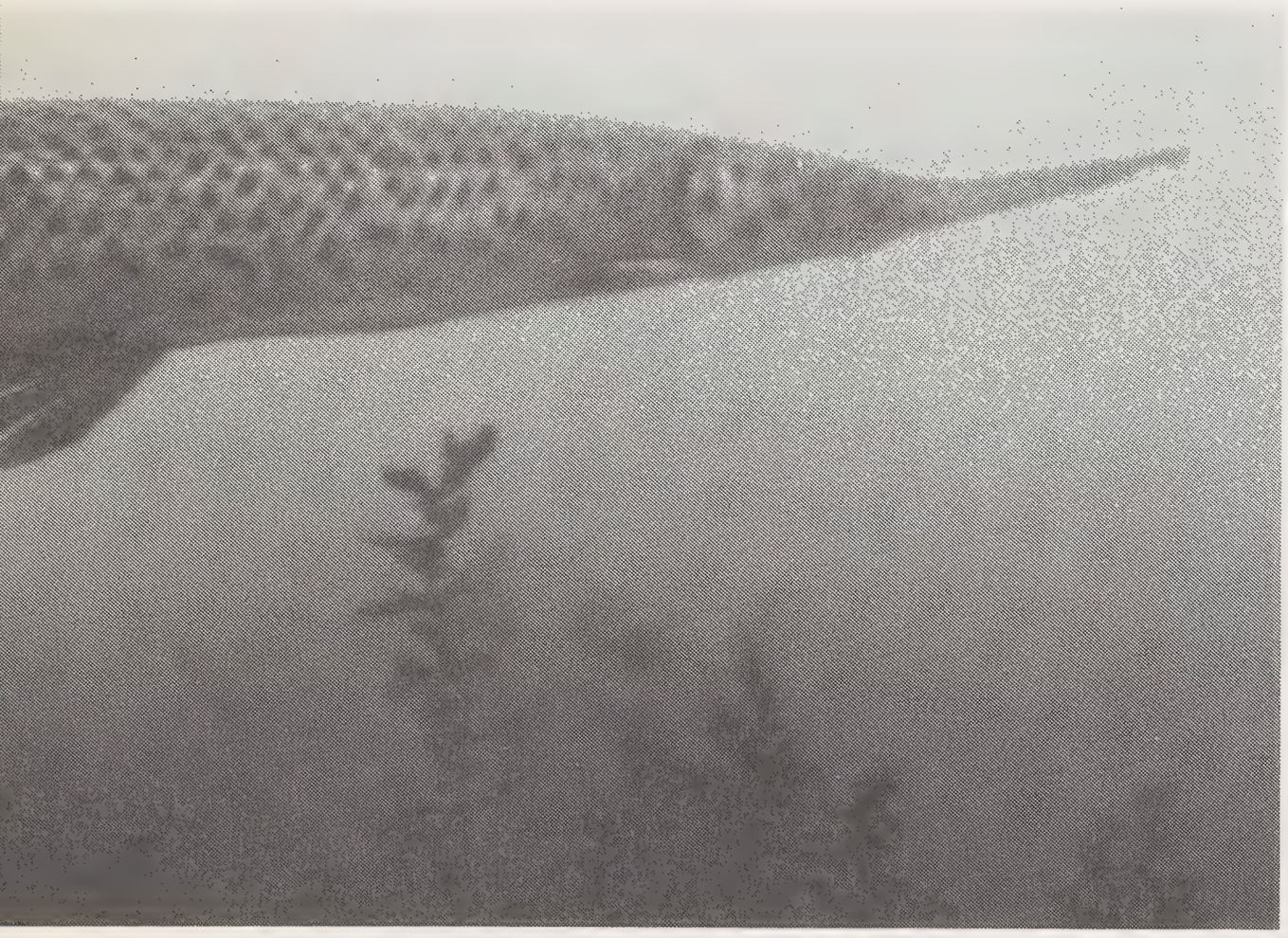
Normally, manatees inhabit the shallow bays and estuaries of tropical coastlines and are so shy they are extremely difficult to approach. The

The graceful, undulating swimming movements of the manatee may have caused sailors to mistake it for a mermaid. However, close observation easily dispels this romantic notion.

exception is Crystal River Springs which, every year from November to March, has a larger number of manatees concentrated in a smaller area than any other place in the world.

During the winter when Gulf of Mexico temperatures drop into the 50s, manatees migrate from the Gulf to warmer waters. A few manatees winter in the Keys; others collect around warm water issuing from power plants, but the majority swim inland to freshwater springs which remain at a constant temperature all year. Crystal River is also a popular skin diving resort, and every weekend the water is crowded with snorkelers and scuba divers. The constant association with divers has caused some of the manatees to lose their fear of humans. Occasionally one of the more adventurous sirenians will engage a diver in aquatic play.

Watching the graceful, undulating swimming movements of sirenians, one is able to understand how superstitious sailors could mistake them for mermaids. They have no hind limbs and the body tapers back to a broad, flat tail. The short forelimbs are tipped with thick toenails and, except in the case of young individuals, are not used for swimming, but appear to come into play when the animals are "walking" or guiding themselves over the bottom. They cruise at a leisurely three to four knots and can reach speeds up to 13 knots, which are maintained only for short periods. Their huge, gray-brown bodies reach lengths over 13 feet with girths up to 6 feet, and they weigh as much as 1,500 pounds.



The slow moving garfish often appears to be merely a drifting stick of wood. However, once in position to attack its prey, it slashes sideways with its long, teeth-studded snout in a frenzy of action.

However, close observation quickly dispels all resemblance to the classic conception of mermaids. The hide of sirenians, particularly around the head and forelimbs, is heavily creased with wrinkles and is so thick and tough that small caliber bullets have been known to bounce off it. The manatee has no natural enemies other than man. Even sharks apparently leave them alone and some scientists believe their rough hide may serve as armor plate protecting them against attack. At any rate, the dugong hide is tough enough to be used for sandals by Indo-Pacific peoples.

The sirenian head is characterized by small eyes and a bewhiskered mouth with thick, pendulous lips. The nostrils are equipped with flaps which close while the animal is submerged and open when it surfaces for air. Sirenians are air-breathing, completely aquatic mammals, unable to pull themselves on shore even for brief periods. This seems an unusual evolutionary adaptation because they are strictly shallow-water animals, inhabiting bays and estuaries always near the shore. Also, sirenians are herbivorous, feeding upon the aquatic plants that grow only in the shallow water of marine estuaries or freshwater lagoons and rivers. Dugongs apparently prefer marine vegetation, but manatees feed upon fresh or saltwater plants with equal relish. Under observation, manatees resting on the bottom have submerged as long as 13 minutes, but when cruising they average only three or four minutes without air.

Manatees have weak eyesight and a poor sense of smell. However, they have an extremely acute sense of hearing. It is not known if their beeps and squeaks are used for echo sounding in navigation. But they are able to travel long distances at night and, in turbid water, to find their way accurately through a maze of shallow flats.

Apparently manatees mate at various times of the year. Calves have been born in almost every month. Males and females do not pair off as couples. Rather, family life is in the form of a herd, and when mating, a number of males compete for the same female. Sirenians are slow breeders and seldom reproduce in captivity or when moved from their natural haunts. A female usually gives birth to a single calf which may weigh anywhere from 35 to 60 pounds. The young are conceived, born, and suckled in the water, and the mother displays considerable maternal solicitude for her offspring. Mammary glands are tucked away near the forelimbs, as with elephants, and the sirenian's dental features are also so similar to an elephant's that scientists believe they may be

Manatees have weak eyesight and a poor sense of smell. However, they have an extremely acute sense of hearing. It is not known if their beeps and squeaks are used for echo sounding in navigation.

descended from the same ancestors. A calf stays with its mother for more than a year. One in Crystal River was attended by its mother for at least two years and did not strike out on its own until it was almost 9 feet long and weighed almost 600 pounds.

The palatability of manatee flesh is controversial, but at one time Dutch vessels in Caribbean waters were equipped to hunt manatees commercially. In the 1800s some enterprising Floridians based a stock promotion upon the sale of "sea beef," which they touted as tastier than real beef. Florida manatees are now protected by law but "sea cow beef" can still be found in a few restaurants in the Keys which claim the meat is imported from Africa. Poaching by hunters remains a major threat to the manatee's existence.

The efficiency of manatees as weed eradicators

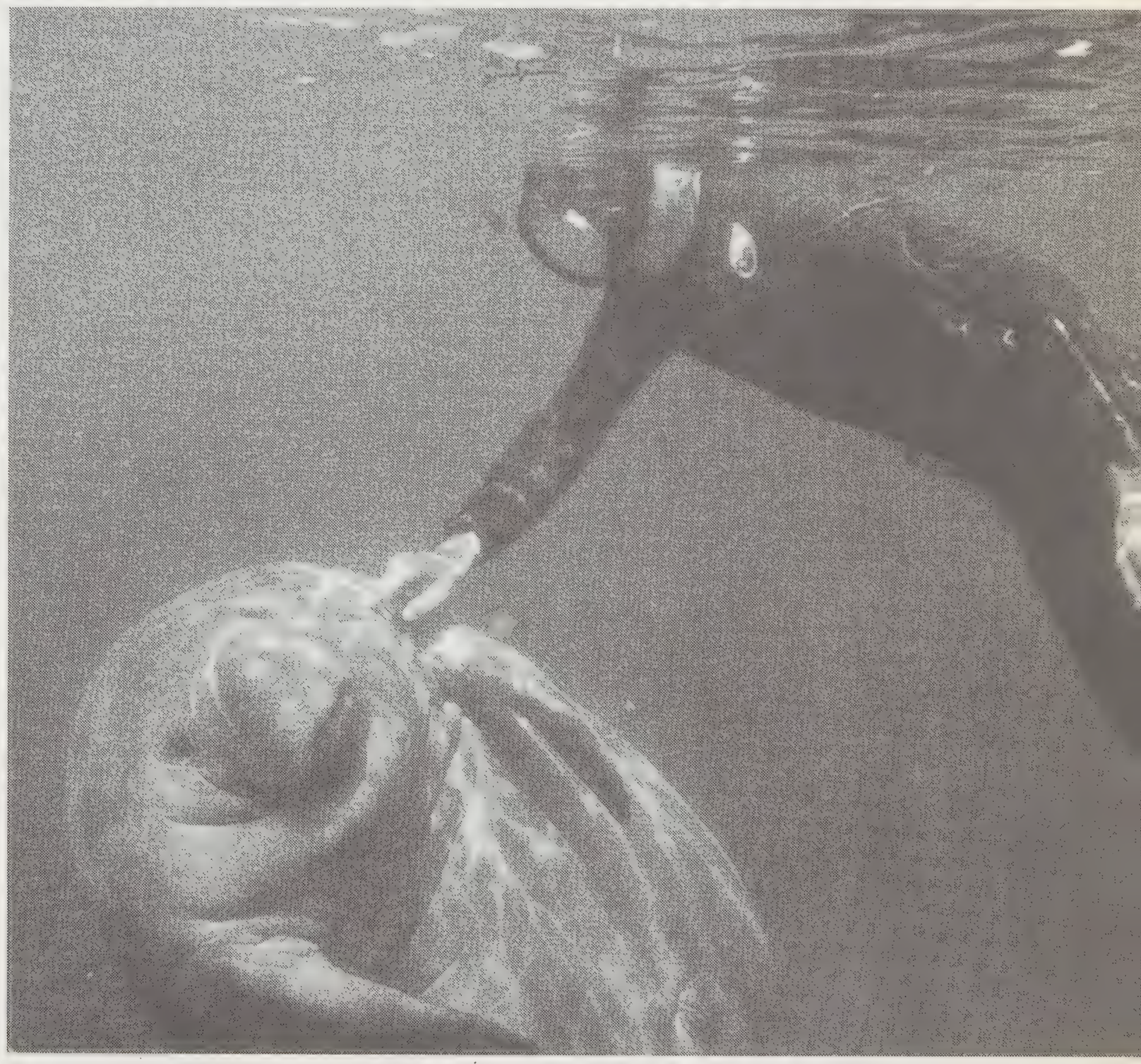
has created new interest in these animals, and a number of attempts have been made to employ them in the removal of noxious weeds from shallow waterways. Tests with manatees in captivity have shown that a single animal will consume one pound of weeds per day for each 10 pounds of its own weight. Equally important, the excrement from manatees is utilized as food by fish and other marine organisms so the water is left clean and unpolluted. A herd of 100 animals, averaging 800 pounds each, could consume an average of 8,000 pounds of noxious weeds a day, so it is easy to understand the excitement with which weed eradication projects were undertaken. So far, however, the results have been disappointing, not because the sirenians failed to perform as expected, but because large herds numbering in the thousands no longer exist, and manatees are so rare that catching and transporting a sufficient number for effective weed eradication is a herculean task. Another problem is the slow birth rate which, combined with the fact that they do not breed readily in captivity, makes the raising of manatees far more troublesome and complicated than raising cattle.

An experiment in Florida, conducted by Florida Atlantic University in cooperation with the Flood Control Department, encountered an additional complication from cold weather and cold water. Since manatees cannot breathe through their mouth, a slight head cold which congests their nasal passages is often fatal. Thus, during the winter when air and water temperatures dropped below 60 degrees, most of the animals died of pneumonia. Others were killed by poachers. Nevertheless, the performance of the manatees in clearing the canal of noxious weeds was so impressive that the experiments are continuing.

However, if the solutions are too long in coming, the manatee may be extinct before the experiments are completed. Every year the herd at Crystal River grows smaller. The hazard that takes the greatest single toll of the manatee's numbers is boat propellers, against which they have no defense. Practically every manatee in Crystal River bears propeller scars on its back, some of which indicate deep and painful wounds. The manatees inhabit water that is often so shallow they cannot escape propellers even by diving, and every time they surface for air they are vulnerable to the blades. The increasing popularity of boating, combined with the rapidly decreasing population of manatees, is hastening the day when manatees will be as extinct as the dinosaur, leaving only legends of mermaids to remind us of their existence.

Usually manatees are so shy that they are extremely difficult to approach. Such is not the case in Crystal River Springs, however, where the constant association with divers has caused some of the manatees to lose their fear of humans.

The skin of the manatees is so thick and tough that small caliber bullets have been reported to bounce off it, yet the sea lice that cover their skin manage to cause a seemingly constant itch.



Author Bill Barada plays with an affectionate manatee, scratching this large sea mammal, which can weigh up to 1,500 pounds, on the stomach.

The cougar is a big animal, which may reach a length of more than nine feet, including two-and-a-half-feet of tail. The cat pictured above and on the following page is a two-year-old male.

Cat of many Names

A Report from Vancouver Island

by David and Lyn Hancock

Cougar, mountain lion, puma, panther, painter, cat-of-the-mountains or cat-o-mount, Indian devil, wildcat: the variety of its names attests to the ubiquitous nature of *Felis concolor.*

The cougar is a large cat. Adult males reach a length of nine feet, including about two and a half feet of tail. The largest known to have been killed in British Columbia measured nine feet six inches and weighed 220 pounds. Its diet may range from moose to mouse, but usually consists of deer.

In the Western Hemisphere, the cougar has had the most extensive range of any native mammal. It is at home in many kinds of habitats – tropical

jungle and temperate forest, pampas and prairie, sea beach and alpine meadows.

As the wilderness disappears, however, so does the cougar. The big cats have but one enemy — man, particularly when he is equipped with dogs, jeeps, and snowmobiles. Already civilized man has exterminated these magnificent mammals from settled areas in southern and eastern Canada and in the central and eastern United States.

The eastern cougar, once thought extinct, has made a comeback in the Maritime Provinces of Canada. Hundreds of cougar sightings had been reported to the Northeastern Wildlife Station at the University of New Brunswick.

Vancouver Island appears to be the center of cougar abundance in the Pacific Northwest, although pockets of high cat populations exist in the Kootenays, Okanagan, and south Cariboa. The factors that contribute to the high numbers of *Felis concolor vancouverensis* on the island include topography, extensive logging operations that have resulted in high numbers of black-tailed deer, and comparatively low numbers of people.

Vancouver Island, in southwestern British Columbia, is about 280 miles long and between 50 and 60 miles wide on the average. The central backbone of the island is mountainous. Large river valleys, lakes, and fiords break up the coastline and penetrate into the interior.

With the advent of logging operations, and subsequent regrowth of valuable Douglas fir, red cedar, Sitka spruce, and hemlock, the black-tailed deer population has built up large numbers. In general the cougar population has expanded with the deer population. The cougar as a predator has helped to thin out the deer on over-populated ranges by removing the weaker animals. However, in severe winters (as in 1969) when deer die off in large numbers, the surplus numbers of cougars that have built up with the years of high deer population must find an alternative food supply. This can be beaver, muskrats, raccoons, grouse, or domestic stock such as dogs, cats, and occasionally sheep.

The cougar usually remains in the cover, lying up by day and hunting during the hours of twilight and darkness. Most of these cats are so shy and secretive that many outdoorsmen never see one unless it is treed by dogs. The keen observer, however, does see regular signs in the form of scrapings, deer kills, tracks on logging roads, or in snow, but the animal is seldom seen by man unless hunted with dogs specially trained for the purpose.

Unfortunately, the cougar has received a bad press, and has been much maligned. This is the case in British Columbia. Whenever a cougar is seen close to urban centers in this part of Canada, it is given wide newspaper coverages, and a conservation officer is sent out to shoot it. Cougars sighted by humans are usually young cats who have been pushed into new territories. If a young cougar is forced into contact with humans — and this is common where the "instant" towns of the logging and pulp industries erupt so suddenly — the animal is easily confused. In a panic to escape, it may find itself fleeing deeper and deeper into human settlements. As recently as 1961, a cougar was shot by startled police in downtown Victoria, the center of a community of 185,000 people.

Whenever a cougar kills a domestic sheep or cow, newspaper front pages show photographs of the animal strung up from a tree or with the hunters posing with guns by the body.

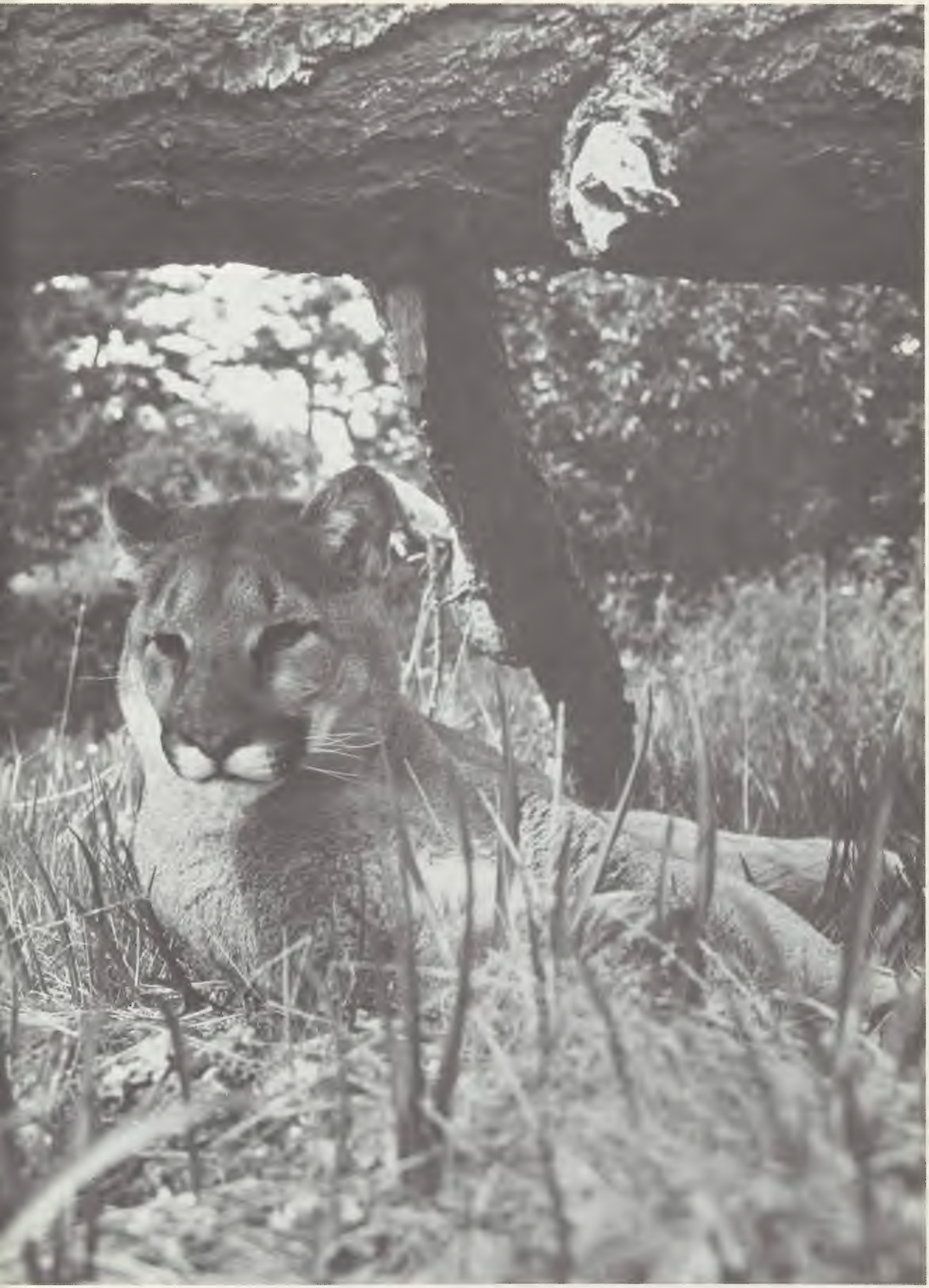
There are many stories about attacks by cougars on humans. But according to the Fish and Wildlife Branch, there have been only eight incidents involving cougar attacks on man in British Columbia. Only one of these resulted in a fatality — a child at Kyuquot on the west coast of Vancouver Island. It is reported that a cougar attacked her dog. When she attacked the cougar with a stick, the cougar in turn swiped at her with its paw, causing her death.

In 1969, three incidents were described in the local press. Two of the three stories concerned starving cougars attacking pet dogs.

Professional cougar hunters differ in their opinions about what causes an animal to attack man or his livestock, whether it be hunger, sickness, or old age. But all agree that such attacks are committed by a small percentage of individuals and not by the vast majority of their kind. One common characteristic of all the cougars which have tangled with man has been that they have been young males.

In the past, many stockmen and hunters have clamored for bounties and more active predator control. Some have called for virtual extermination of the species. Bonus hunters were paid $20 for shooting a cougar. In 1953 bounty laws were repealed, and control of specific marauders placed in the hands of conservation officers of the provincial Fish and Wildlife Branch.

A cougar rests in the woods of Vancouver Island, British Columbia. The island has a large population of these cats.



Since 1965, British Columbia and six western states of the United States (Colorado, Washington, Utah, Nevada, Oregan, and California) have classified the cougar as a game animal. This means that control and harvest of them is left primarily to sportsmen.

A British Columbia Fish and Wildlife Branch pamplet explains more pointedly: "In a few of the mountain states (of the United States), cougar hunting has become a flourishing business and sport. There is no reason why it should not succeed here . . . it should be encouraged at every opportunity."

The economic benefits have been carefully measured. Non-resident big game hunters, most of them from the United States, spent an average of $568 each in British Columbia during a recent season. About $4,000,000 was spent by non-resident hunters in 1967, the last year of record.

As the number of cougar guides increase, a game department official says a tag system for cougars will evolve. The existing season limit on cougars on Vancouver Island is five per hunter. Cougars may be hunted all year around except in the Kootenay region, where the hunting season is during the six months of the winter. Although cougars have their litters all year around, the majority of young are born in the winter.

The reported cougar kill by sportsmen in British Columbia for 1967 to 1968 was 1,406 animals, compared to an estimated 70,000 deer taken the same year. According to preliminary figures released by the Fish and Wildlife Branch, 586 cougars were killed by hunters in the province during 1968-69. Until a tag system is introduced, we may not know how reliable these figures are — and whether more cougars are shot than reported. The number of cougars shot (586) according to this latest report coincides with the number shot

The cougar is an efficient predator and a particularly valuable check on rodent populations. It serves to cull weak and unfit individuals from deer herds.

Once found throughout most of North America, the cougar's range has been greatly reduced. In the United States, the only significant populations are west of the Mississippi.

during an average year of the bounty regulations. The Fish and Wildlife Branch thinks the cougar population is healthy and "able to withstand heavy hunting pressures."

However, there have been numerous sightings of cougars closer to centers of populations during the past two or three years, which has resulted in a demand by diehard predator control advocates for return of the bounty system.

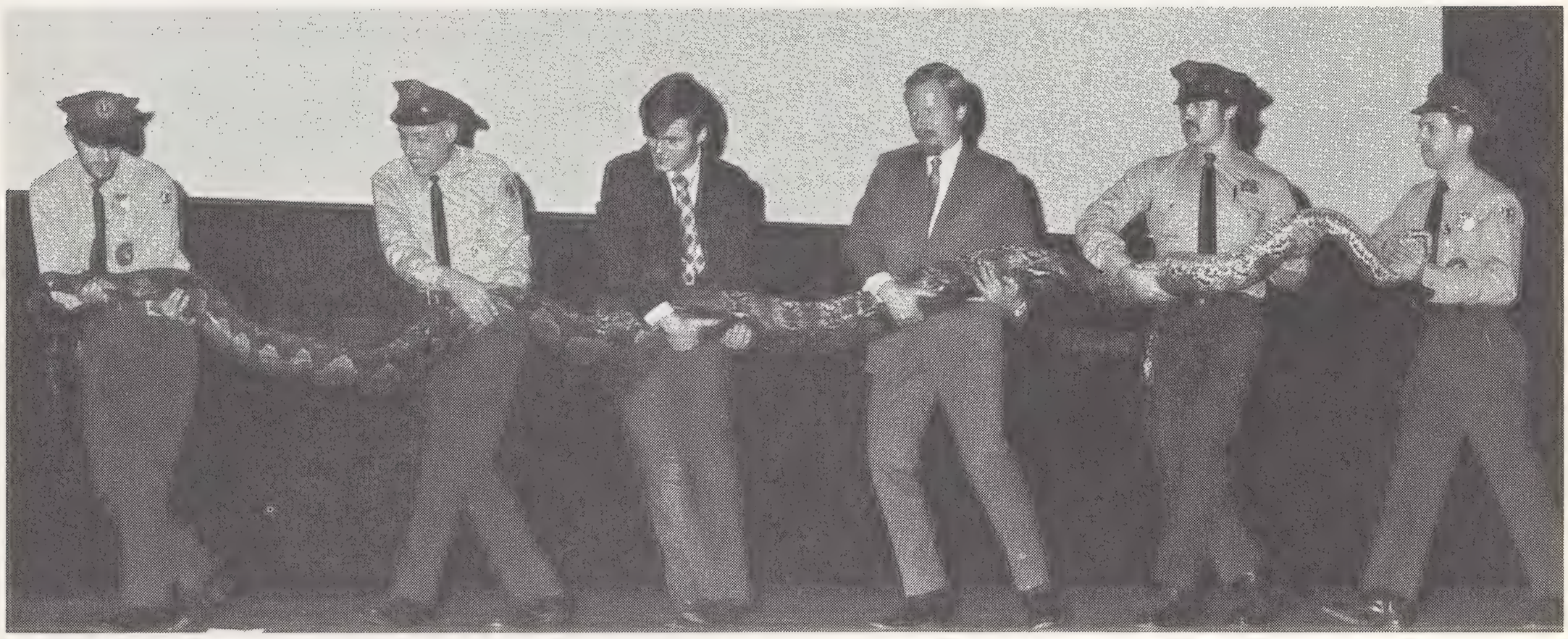
It is certain that the cougar is running out of wilderness range. But the Fish and Wildlife Branch says that the recent increased sightings of cougars are directly related to the big snows of the previous winter, which reduced the island's deer population by as much as 80 percent in some areas.

Whether or not cougars are increasing on Vancouver Island, no cat escapes the good cougar hunter with his trained dogs, and the number of hunters is increasing rapidly. Three thousand three hundred forty-nine hunters turned in reports during 1968-69. According to one experienced predator hunter, "The cougar is one of the few animals that could be systematically exterminated because the once vast untracked wilderness is now being criss-crossed by myriads of logging, access, or fire roads. Now it is a simple matter of driving along the many roads till you see a set of tracks leading up the mountain."

The cougar is a valuable check on rodent population. In deer country they are an asset, for deer will overpopulate and overgraze a range until there is no alternative but mass starvation or feeding the deer at public expense. Natural limitation by predators weeds out the unfit of the species.

The tragedy of the cougar is that despite its nobility of appearance and behavior, it must give way in the name of progress to its only enemy — man.

animal kingdom
REPORTS



One of the highlights of the seventy-fifth annual meeting of the New York Zoological Society was the measuring on stage of a large reticulated python from the Bronx Zoo. Lending a hand for the occasion were (left to right) Randy Rowe, Vincent Pepe, William Elliott, Eric Edler, Dennis Daly, and Peter Brazaitis.

Seventy-fifth Annual Meeting of the New York Zoological Society Held at Philharmonic Hall

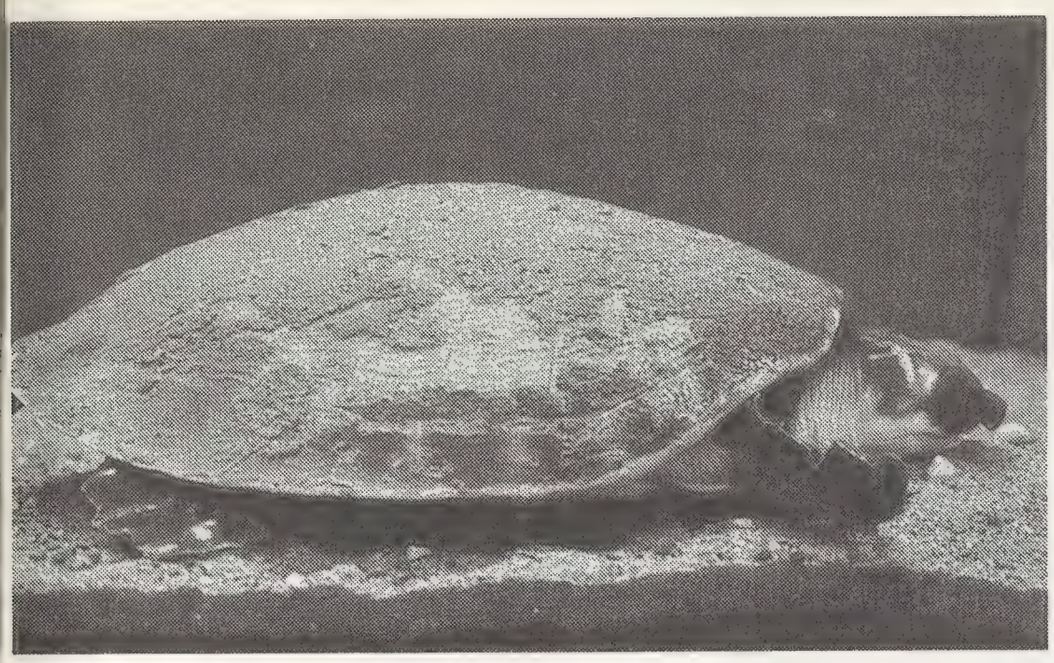
More than 4000 members of the New York Zoological Society turned out January 19 for the society's 75th annual meeting, which was highlighted by live animal exhibits and films on the society's history and achievements in research and conservation.

President Robert G. Goelet, in his first report to the membership, reviewed developments and activities of the past year, and stressed that the society's concern with wild animals and wild places is especially revelant in today's world.

"Our threefold mission in education, conservation, and research is of basic importance to a realization of the potentials of man and the quality of his life in a world whose very ecological support systems are threatened," Mr. Goelet said.

A series of enlargements of photographs depicting historic events in the society's history was displayed in the lobby of the Philharmonic Hall, Lincoln Center, site of the meeting. Exhibits featuring live wild animals also were on display in the lobby. The exhibits illustrated some of the ecological problems of the day. An exhibit from the New York Aquarium, which housed a number of large striped bass, depicted the food chain of the sea and the manner in which pesticides travel along the chain. Another exhibit, this one developed by the Bronx Zoo, housed a brown pelican, a member of a species that has become a prime victim of pesticides in the food chain. The pelican is in danger of extinction because of the effect of pesticides on its ability to reproduce.

Members of the society had a chance to meet some of the society's staff, as well as a number of zoo animals, which included a boa constrictor, a hedgehog, and a tamandua, a furry little anteater from Mexico, Central America, and South America.



This pitted-shell turtle, on exhibit at the Taronga Park Zoo, Sydney, Australia, was collected in the Daly River of Australia's Northern Territory. The Bronx Zoo has a specimen of pitted-shell on exhibit in its reptile and amphibians building.

Pitted-shell Turtles Found in Australia

The pitted-shell turtle, generally considered a zoological rarity, lives in the Fly River drainage of southeastern New Guinea, and it has long been thought that the creature's range was confined to that region.

Now, according to a report from the Taronga Park Zoo, Sydney, Australia, there is evidence of a population of these turtles in Australia's Northern Territory. Ten specimens of the pitted-shell turtle were caught by a fisherman in the Daly River of the Northern Territory. One specimen was lost, eight were released, and one was placed in the Taronga Park Zoo, where it is on exhibit. Australian biologists are now trying to determine if the Daly River population of the pitted-shell turtle is introduced or natural.

Dr. F. Wayne King Appointed Educational Chairman

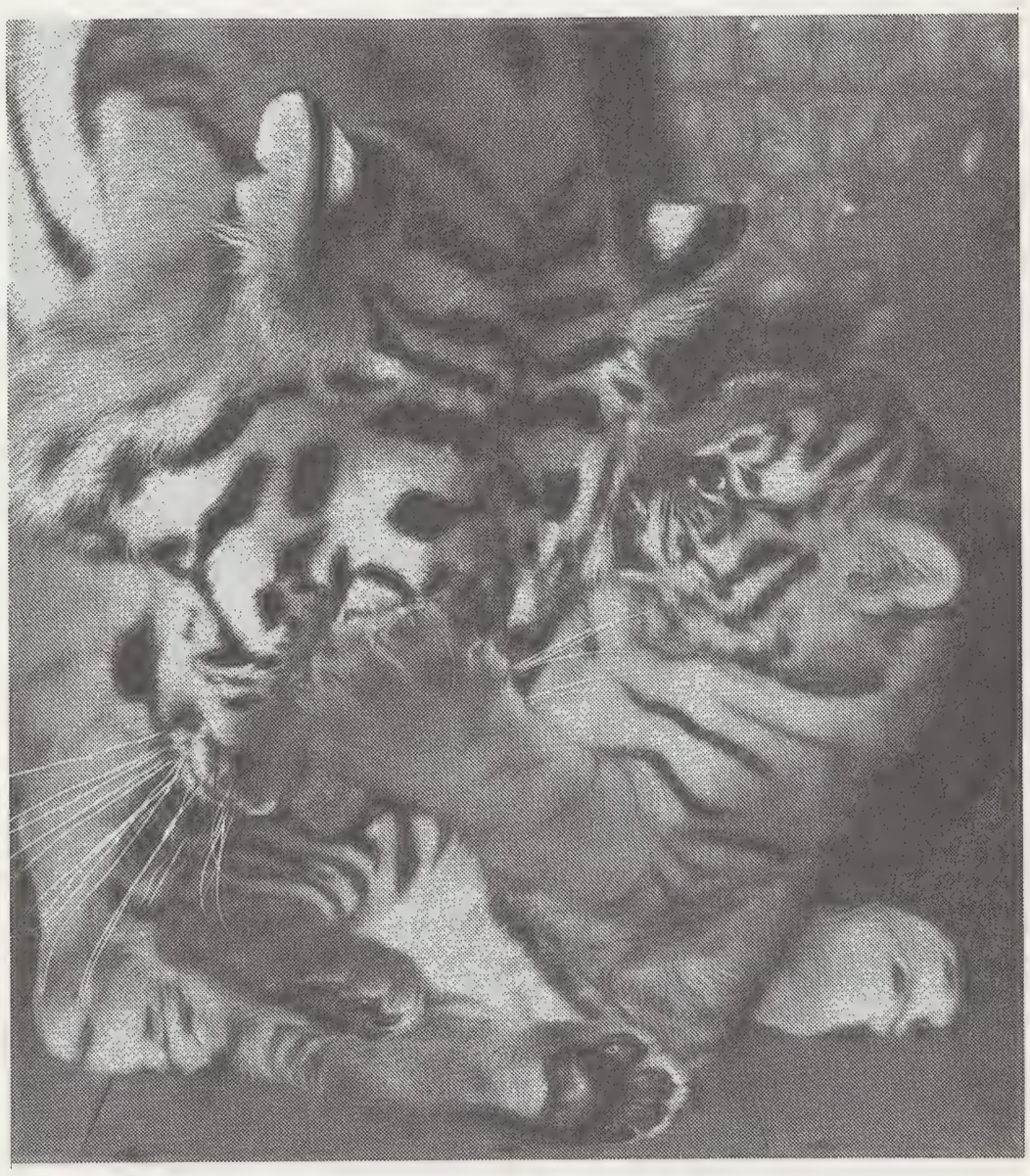
Dr. F. Wayne King, Curator of Herpetology at the Bronx Zoo, has been appointed Chairman of Educational Programs for the New York Zoological Society. In addition to his present curatorial duties in the herpetology department, Dr. King will coordinate educational programs for the zoo and the New York Aquarium, both of which are operated by the society.

The society's education department conducts a variety of programs, including summer courses for children, an in-service teaching course for school teachers, and the Living Science Program, a New York State urban education project, with Bronx School District # 10. Brooklyn School District # 21 also has a program, Man and His Environment, in cooperation with the New York Aquarium.

Among the programs in preparation is a training course for volunteer zoo guides, scheduled to begin this spring. Dr. King also will be coordinating new programs with the aquarium and further developing a project in which day care centers utilize some of the facilities of the Bronx Zoo's Children's Zoo.

Dr. King has had considerable experience studying and collecting reptiles and amphibians, including field trips to Indonesia in 1968, 1969, and 1970 to study the world's largest lizard, the Komodo monitor. A member of the American Alligator Council and the Conservation Committee of the American Society of Ichthyologists and Herpetologists, Dr. King has taken an active part in the efforts to conserve the world's crocodiles, alligators, and caimans.

Dr. King received his B.S. and M.S. from the University of Florida at Gainesville and his Ph.D. from the University of Miami (Florida). He was a research associate at the Florida State Museum a department of the University of Florida, Gainesville, before coming to the Bronx Zoo as Associate Curator of Herpetology in 1967. Dr. King and his wife Sherry live on the zoo grounds.



Only a mother could put up with such antics, as the female Siberian tiger attempts to wash one of her playful cubs at the Bronx Zoo. The youngster is one of three cubs, a male and two females, born on August 17, 1970, in the zoo's Lion House.

THE bookshelf

ADVENTURE WITH EAGLES. *By David Hancock. Photographs by David and Lyn Hancock. 40 pages, soft cover. The Wildlife Conservation Centre, Saanichton, British Columbia, Canada, 1970.*

Have you ever seen an eagle in the wild? David Hancock has. For many years he has been studying bald eagles and their ecology on their last real stronghold, the northwestern coast of North America. Imagine seeing 27 bald eagles in one place at one time, or even traveling through a 400 square-mile area where there were 170 active bald eagle nests.

The real fault with *Adventure With Eagles* lies in its brevity. Certainly David Hancock, who, incidentally, collected the Bronx Zoo's colony of tufted puffins, must soon enlarge on these brief notes about this great raptore, known by legend to every American but seen and understood by only a very few.

Joseph Bell

THE NATURAL HISTORY OF DOGS. *By Richard and Alice Fiennes. Published for the American Museum of Natural History, The Natural History Press, Garden City, New York, 1970. $7.95.*

Little is contributed by this book to the domestic dog's intriguing story. In fact, the book in some areas is extremely misleading, erroneous, and superficial. The lack of zoological depth or background on the part of the authors is appalling.

Perhaps the basic flaw in this book, which is an over-riding influence throughout, is that with apparent lack of knowledge or experience in this field, the authors have relied for their source of wild canid taxonomy and natural history on a book which was published in 1890. St. George Mivart's *Monograph of the Canidae* is an admirable work in its own right and time, but is abused by the authors to be used as a basic source now when so much information and research has accumulated over the intervening years. This is regretable because the subject does have a wide appeal, and the book is superficially attractive and many people will undoubtedly be persuaded to acquire it. It is especially regretable because many elements of the story are now available, and there is a need of a good book of this scope.

Hugh B. House

DISEASES OF FISHES. BOOK 1: CRUSTACEA AS ENEMIES OF FISHES. *By Z. Kabata. Stanislaus F. Snieszko and Herbert R. Axelrod, Editors. T. F. H. Publications, Jersey City, New Jersey, 1970. $7.95.*

This book is the first in a series of proposed texts on diseases and parasites of fishes. If the other publication will be as excellent as this critical evaluation of the importances of crustaceans as fish parasites by Dr. Z. Kabata, an eminent parasitologist of the Fisheries Research Board of Canada, the series will be an invaluable contribution to the American literature on fish diseases.

R. F. Nigrelli

ABOUT THE authors

Bill Barada is a Florida-based writer whose articles on the outdoors have appeared in many magazines. **Donald M. Christisen** is a research biologist with the Missouri Department of Conservation. **David and Lyn Hancock** operate a wildlife research station on Vancouver Island, British Columbia. They have authored a number of articles and books on nature. **Robert A. Morris**, former curator of the New York Aquarium, is now at Cornell Veterinary College.

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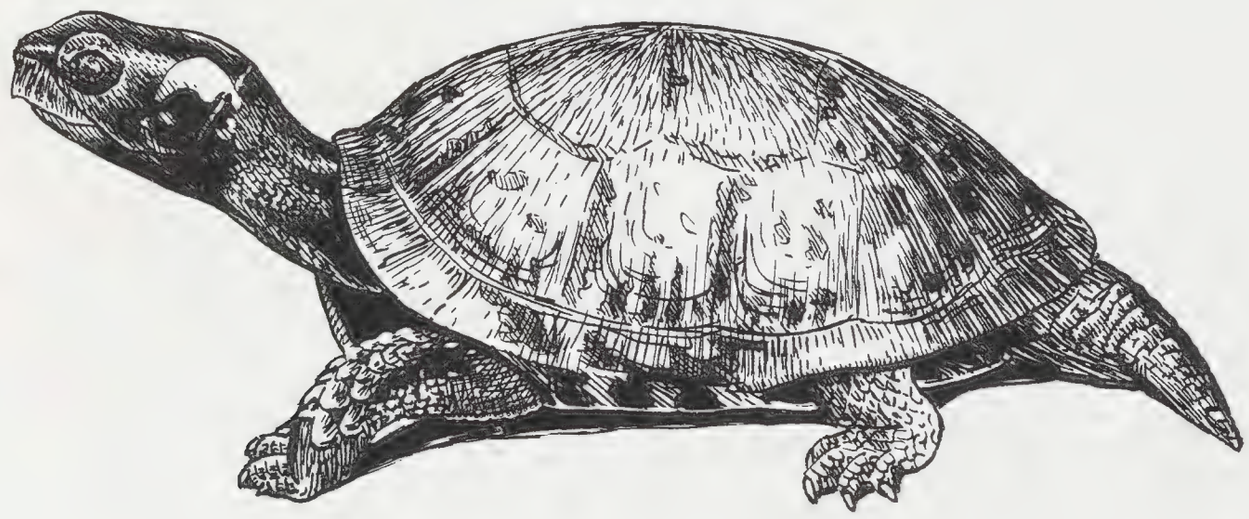
DYING SPECIES...

"The beauty and genius of a work of art may be reconceived though its first material expression be destroyed; a vanished harmony may yet again inspire the composer; but when the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can be again."

William Beebe
First curator of birds, Bronx Zoo



Bog Turtle

Clemmys muhlenbergi

Late in the eighteenth century, Heinreich Muhlenberg, a clergyman and botanist, discovered an unknown turtle in the bogs and swamps of Lancaster County, Pennsylvania. The tiny turtle, scarcely four inches in length, resembled the common spotted turtle in shape but bore a striking orange splotch on either side of its head. In 1778, Rev. Muhlenberg passed along his findings to Dr. Johann David Schoepff, a German physician and naturalist, who was attached to a Hessian regiment fighting with the colonists during the American Revolution. Thirteen years later, in 1801, Dr. Schoepff published his *Historia Testudinum* and named the new turtle in honor of its collector.

Since the year of its discovery, *Clemmys muhlenbergi* has remained one of our rarest and most mysterious reptiles. Both the International Union for the Conservation of Nature and Natural Resources and the United States Department of the Interior include the bog turtle on their rare and endangered species lists.

Bog turtles, as their name implies, make their home in mucky bottomed, poorly drained habitats. Sphagnum, tamarack, and skunk cabbage are almost always in evidence. Warmed by April sunlight, the bog turtle leaves its winter retreat and begins to patrol its domain in search of invertebrate prey. On the warmest days, the turtle climbs to the top of a grassy tussock and basks by the hour. In June or July, the female deposits three or more one-and-one-quarter-inch eggs in a shallow depression in damp moss. Seven or eight weeks later, the one-inch replicas emerge.

In the last 170 years, the little turtle has been reported from ten of our eastern states. In total, it ranges from western Massachusetts and central New York south to the western-most reaches of North Carolina. Unquestionably, the species is rare throughout the entire range and, with minor exceptions, the existing colonies are separated from one another by many miles.

Perhaps the natural gaps between populations can be attributed to ecological succession. Almost completely restricted to boggy environments, the bog turtle is continually faced with habitat shrinkage. As time passes, the sphagnum bogs fill with their own debris and are colonized by invading hardwood trees.

Although natural processes may spell the fate of this diminutive species, it is far more likely that the activities of man will seal their doom.

Each year our burgeoning society places increasing demands on our natural resources, and under the guise of land "reclamation," bulldozers eat away at "muhley's" home. This unnatural selection pressure has been felt in all parts of the bog turtle's range, but has been especially severe on populations in New Jersey and southeastern Pennsylvania.

Over-collecting, too, has accelerated the demise of the bog turtle. Scientific collection, however, compared to the thirsts of the pet industry and private collectors, has placed small burden on the turtle's numbers. The bog turtle's ever increasing scarcity makes its capture so much the more lucrative for the commercial collector.

To date, only New York State provides any degree of protection for the bog turtle. In that state, it is unlawful to keep them in captivity or to offer them for sale. Unfortunately, the law is often ignored and their sale and collection continues.

Obviously, the bog turtle is in trouble throughout its entire range. Its accelerated demise has clearly come at the hands of man. While it is altogether possible that this species may one day be conserved and perpetuated in zoological parks, it is an integral part of the bog ecosystem and merits full protection.

JOHN L. BEHLER, JR.

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ABOUT THE COVER

Front: The marbled salamander *(Ambystoma opacum)* is one of the mole salamanders, a fascinating family found only in North America. John L. Behler, Jr., tells the story of these amphibians in a two-part series beginning in this issue (see page 2).

Back: White-handed gibbon *(Hylobates lar)* is native to Cambodia and southwestern Thailand through the Malay Peninsula to Sumatra; a family of this species swings through the trees on Gibbon Island from May to November at the Bronx Zoo.

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The tiger salamander, right, is the largest terrestrial salamander in North America. Its maximum length is more than a foot.

Dusk is settling over the woodland as a stiff wind, edged with the chill of mid-March, rattles the bare branches of the trees. Below, on the woodland floor, now beginning to soften on sunny days, a small creature is stirring ever so quietly. Creeping through the leaf litter, slowly but with apparent purpose, it works its way overland toward its destination – a shallow puddle formed by melted snow in a sheltered depression in the ground.

Throughout the woods there are similar stirrings, as other members of the traveller's species journey toward the puddle. The spotted salamanders have emerged from their winter hiding places and are headed for the water in which they will breed.

Spotted salamanders belong to a family of salamanders whose members are seldom seen except during their brief migratory trips to breeding ponds. As adults they stay underground most of the time, and as a result are called the mole salamanders.

The migration phenomenon apparently is triggered by a rather precise set of environmental conditions which roust the salamanders from their retreats and send them in one great rush to the breeding sites. After a brief courtship and egg laying, the mole salamanders retrace their steps and virtually disappear for another year.

Mole Salamanders

Dwellers in Secret Places

by John L. Behler, Jr.

These secretive amphibians for the most part are sturdily built and possess broad heads with blunt snouts. They belong to the family Ambystomidae and are found exclusively in North America.

Of the four genera in the family, the primitive *Rhyacosiredon* is found only in the high mountains at the southern edge of the Mexican plateau. Only four species of this genus are known to science.

Two additional genera, *Dicamptodon,* the Pacific giant salamander, and *Rhyacotriton,* the Olympic salamander, have but one species each and are confined to the humid coastal region of the northwestern coast of the United States and Canada. *Dicamptodon* is one of the few salamanders which is capable of producing sounds. If disturbed, it startles its adversary by emitting barking or rattling sounds. Unlike its relative *Dicamptodon,* which may attain an adult length of twelve inches, *Rhyacotriton* barely exceeds four inches and is characterized by its relatively large, bulging eyes and the presence of vestigial lungs.

The fourth genus, *Ambystoma*, includes the largest known terrestrial salamanders. Its members live from the Atlantic to the Pacific coasts. The range of these salamanders extends from southern Labrador, James Bay, and southeastern Alaska,

Unlike the other mole salamanders, which breed in the spring, the marbled salamander, left, breeds in the autumn.

The spotted salamander breeds in the early spring, even before ice has left the surface of the breeding ponds. They congregate in large numbers in woodland ponds and puddles.

south through most of the United States to the Sierra Madre Occidental and central plateau of Mexico.

Twenty-nine *Ambystoma* species, three of which are known only from their fossil remains, have been described by scientists. Of the living species 14 occur in the United States, six of which also live in Canada and one in Mexico. The remaining 12 inhabit only Mexico.

In the northeastern states, the heavily-bodied mole salamanders are represented by seven species; they are commonly called the spotted, marbled, tiger, blue-spotted, silvery, Jefferson's, and Tremblay's salamanders.

The largest of these, the tiger salamander *(Ambystoma tigrinum),* in its many races, is the most widely distributed mole salamander in the United States. The eastern form is found in the lower Hudson Valley and parts of Long Island, and ranges southward to northern Florida and west to South Dakota and eastern Texas.

Not only does the tiger salamander enjoy a wide distribution but it also has been recorded from sea level to some of the nation's highest lakes. It seems to do well in all biotic communities throughout its range which have substrates suitable for accommodating its burrowing nature. The tiger salamander can grow a foot long. In North America only two other salamanders, the aquatic mudpuddy and the hellbender, are longer. In the western states, where some aquatic larvae of this species fail to transform to the land stage, the unmetamorphosed larvae, or neotenes, become quite large, often reaching more than a foot in length.

Eastern tiger salamanders can be recognized by the irregular shaped olive or yellow blotches which cover their black or deep brown colored back. Each spring, in typical mole salamander fashion, the tiger salamanders leave their winter havens and migrate to the ancestral ponds where courtship, breeding, and egg laying take place.

The marbled salamander *(Ambystoma opacum)* averages only about four inches in length and is the smallest ambystomid in the Northeast. Like other members of the group, the marbled salamander possesses numerous slime glands on the entire dorsal surface of the body and is equipped with minute teeth, which extend in a transverse line from one side of the jaw to the other. Silvery crossbands on a deep lustrous black background serve to distinguish this handsome species from all other salamanders in its range.

The marbled salamander shares most of the tiger salamander's distribution pattern; however, as a less aquatic form, the marbled prefers drier situations than other eastern mole salamanders. Unlike the spotted and tiger salamanders which usually burrow rather deeply, the marbled salamander hides just beneath surface debris on sandy hillsides which overlook suitable breeding ponds. And in striking contrast with all other mole salamanders, the marbled salamander makes its way to the breeding waters during the autumn months and deposits its eggs on land.

Four of the seven northeastern ambystomids belong to the closely related *Ambystoma jeffersonianum* complex. The complex is composed of the Jefferson's salamander *(A. jeffersonianum),* the blue-spotted salamander *(A. laterale),* the silvery salamander *(A. platineum),* and Tremblay's salamander *(A. tremblayi).* All of these closely resemble one another, so much in fact, that for most of the last 50 years only a single species, *A. jeffersonianum,* was recognized.

This oversight is easily understood, as members

of the group are all moderately slender for mole salamanders and are typically brownish-grey in color with pale blue flecks present on the undersides. Adults usually average about five-and-one-half inches to seven inches in body length. Close investigation indicates slight differences in body proportions and color patterns.

Thomas M. Uzzell of Yale University's Peabody Museum, who has investigated the genetic makeup of this group, believes that the "Jeffs" and "blue-spots" differentiated about 25,000 years ago during the Wisconsin glaciation. The glacier probably served as a natural barrier that divided the ancestral stock and allowed the blue-spotted salamanders to arise from populations isolated between two spurs of the glacier in what now is the state of Wisconsin, and the Jefferson's salamander from populations isolated south of the ice mass.

Collectively, the Jefferson complex ranges from southern Labrador and southeastern Manitoba to Virginia and Kentucky. In general, the blue-spotted salamander occupies the northern and more western parts of the range, while the "Jeffs" are found in the southern portion of the range. These two species intergrade in New England and in central New York. The silvery salamander and Jefferson's salamander are associated in the western portion of the "Jeffs" range, while the Tremblay's salamander and blue-spotted salamander coexist within the eastern deciduous forest.

The spotted salamander's *(A. maculatum)* identity is unmistakable. Averaging slightly larger than the Jefferson's, the "spotty" has rich bluish-black background color broken by two or three dozen brilliant yellow or orange spots. Because of its fossorial habits, the "spotty," like other mole

The tiger salamander is extremely aggressive and preys on a variety of small animals, from insects to young mice. It has several races.

salamanders, is rarely observed during the non-breeding season. Nevertheless, it is the ambystomid most frequently encountered in the northeastern deciduous forest.

Although little is known of the terrestrial life of adult mole salamanders, the courtship, breeding, and egg-laying habits are well-studied. The spotted salamander's activities are representative of this group.

Stimulated by spring showers or high humidity and unseasonably warm March weather, the "spotty" takes leave of its terrestrial quarters and begins its annual pilgrimage to the breeding sites. The migration usually begins soon after dark and may continue until dawn. Although slow streams and occasionally swamps are used as breeding sites, the vernal pond and smaller temporary woodland pools are most frequently visited.

If satisfactory conditions prevail, the migration may take on the appearance of a "breeding swarm," in which large numbers of "spotties" arrive at the nuptial site in apparent unison. Frequently, however, cold snaps interfere, and not all individuals make the complete trip on the first night of suitable conditions. In this case, it is not unusual to find the early arrivals beneath a sheet of ice. Rarely, inclement weather will keep the migrants from reaching their destination until mid-April or even later.

The migration of the mole salamanders to their breeding sites obviously involves some sort of orienting mechanism. Since migration typically occurs at night under the cover of heavily overcast skies, most investigators agree that celestial cues probably do not play an important role.

Other biologists have attributed the breeding pond orientation as a response to the downhill slope of land or perhaps to currents in streamlets formed during spring showers. These suggestions, at least for those species of *Ambystoma* which migrate over considerable distance, can be refuted on the basis that migrating individuals occasionally move up and down hills and across stretches of woodlands and meadows which lack temporary streams.

The work of the late Victor C. Twitty, Stanford University biologist and authority on salamanders, presents strong evidence that Pacific newts, *Taricha,* utilize olfactory cues in reaching their migratory goal. While olfactory cues may play an important role in *Taricha* orientation, the sensory mechanisms of this phenomenon in ambystomids remain an unsolved mystery.

The climatic factors which influence the "spotties" to migrate also serve to stimulate other species of mole salamanders. Jefferson's salamander occasionally shares the same breeding sites with the spotted salamanders.

In many situations, the "Jeffs" arrive at the ponds several days in advance of the spotted salamanders. This is especially true when the pond is the only suitable breeding site in the vicinity. Since spotted salamanders often wander considerable distances from breeding waters during the summer months, while the Jefferson's salamander occupies quarters closer to the ponds, it is not surprising that the "Jeff" makes the journey in less time.

For some unexplained reason, male mole salamanders frequently arrive at nuptial sites slightly before the females. Males are characteristically more slender than the females and are identifiable by their greatly enlarged and protuberant vents. As the females arrive, both sexes congregate in large numbers in a limited region of the pond and begin the courtship.

The male mole salamander lavishes his partner with nosing and butting and then rushes to a nearby twig to deposit a half-inch vase-shaped spermatophore.

After the female mole salamander has retrieved the spermatophore and internal fertilization has taken place, a day or two passes before egg deposition occurs. The female spotted salamander selects a submerged twig or weed to support her

Meteorological conditions may stimulate breeding behavior in the spotted salamander and other mole salamanders as well.

A pair of spotted salamanders is pictured with its egg mass. Spotted salamanders are among the first amphibians to breed in the spring.

egg mass. As many as 250 eggs are attached to the branch about six inches below the water's surface.

Initially, the total complement is quite small in size and is normally less than an inch in diameter. The mass, however, rapidly absorbs water and swells to three or four times its former size. The number of masses and the number of eggs deposited in each may vary from one or two per mass in the blue-spotted, a dozen or so per mass in Jefferson's, to 50 to 100 per mass in the tiger and spotted salamanders. However, all begin their development in the spring well below the pond's surface.

Other than the wood frog *(Rana sylvatica)* – the first of the North American frogs to leave hibernation – and the spring peeper *(Hyla crucifer)*, few vertebrates witness the spring breeding activities of the mole salamander. In some ponds, however, larval ambystomids are already present when the breeding contingent arrives.

It is during the fall, usually in September or the first part of October, that the marbled salamanders congregate beneath the matted litter along the margins of dried woodland ponds. After courtship, the females select little cavities in the leaf mold and singly deposit 50 or more eggs.

Unlike the other mole salamanders, the female "marbled" does not abandon her eggs immediately. It is not uncommon for investigators to find the female curled about the developing clutch – perhaps providing protection from drying or predation by other salamanders or insects. After several weeks have past, the early winter rains inundate the eggs and provide a medium in which

the hatching larvae flourish.

The incubation period for mole salamander eggs varies, not only with the species but also the season. Eggs deposited in the fall by the marbled salamander may hatch in as little as 15 days, or not until spring if fall rains do not cover the clutch. "Jeff" and "tiger" larvae spend 30 or more days encased in their gelatinous envelopes, hatching out a week or two before the more slowly developing spotted salamander.

Egg masses of the spring breeders often appear like balls of cotton beneath the water's surface, but feel much like a handful of gelatin when lifted from the pond. The transparent or semi-opaque jelly of the egg mass frequently takes on a green tint, as a symbiotic green algae develops among the eggs without causing them harm. Many eggs in the mass are not as fortunate and suffer a premature death from the invasion of *Saprolegnia* – a lethal mold which destroys the developing larvae and turns the mass an opaque white.

Caddis fly larvae, which are common in many breeding ponds, may also invade the masses and increase their susceptibility to disease and predation. Somehow, a number of the masses survive nature's ravages, and the pond becomes alive with young larvae searching out microscopic organisms to eat.

The larval period, like the egg stage, is subject to a multitude of ecological pressures. Hatchlings become meals for predatory insects as well as marauding reptiles, shore birds, and other vertebrates utilizing the pond's food chain. Of far greater consequence is the possibility that unseasonably warm weather can dry the pond before metamorphosis to adulthood takes place. Larvae of ambystomids living in arid areas of the Southwest and Mexico frequently suffer this fate.

Northeastern mole salamander larvae are approximately a half-inch in length at hatching and appear somewhat like minute tadpoles with long filamentous gills radiating from both sides of the head. Except for the hatchling "tiger," small balancing structures project downward from the chin.

Growth occurs rapidly and within the span of a month the larvae exceed an inch in length and begin to look like salamanders. By this time, the balancers are gone and both front and hind limbs have appeared. The developing larvae are carnivorous and feed on the pond's abundant planktonic material. If marbled salamander larvae are sharing the pond with other larvae, they may take advantage of their larger size and dine on the younger forms.

In those ponds occupied by "Jeffs" and "spotties," a successional sequence of events permits the larvae to exploit the pond's ecosystem successfully. Several factors make this possible. Since the Jefferson's eggs are laid earlier and develop more quickly, the larvae hatch a week or so before the spotted salamander's. During this time span, the "Jeffs" increase in size and begin selecting larger food items.

Both of these species spend most of the daylight hours hidden beneath the debris at the bottom of the pond. As evening approaches, the larval "Jeffs" migrate upward and remain suspended below the surface to feed on rising plankton. Meanwhile, the "spottys" seem content to forage about the floor of the pond. Although the larvae have utilized essentially the same food and habitat, their individual feeding styles permit them to coexist and successfully to complete metamorphosis.

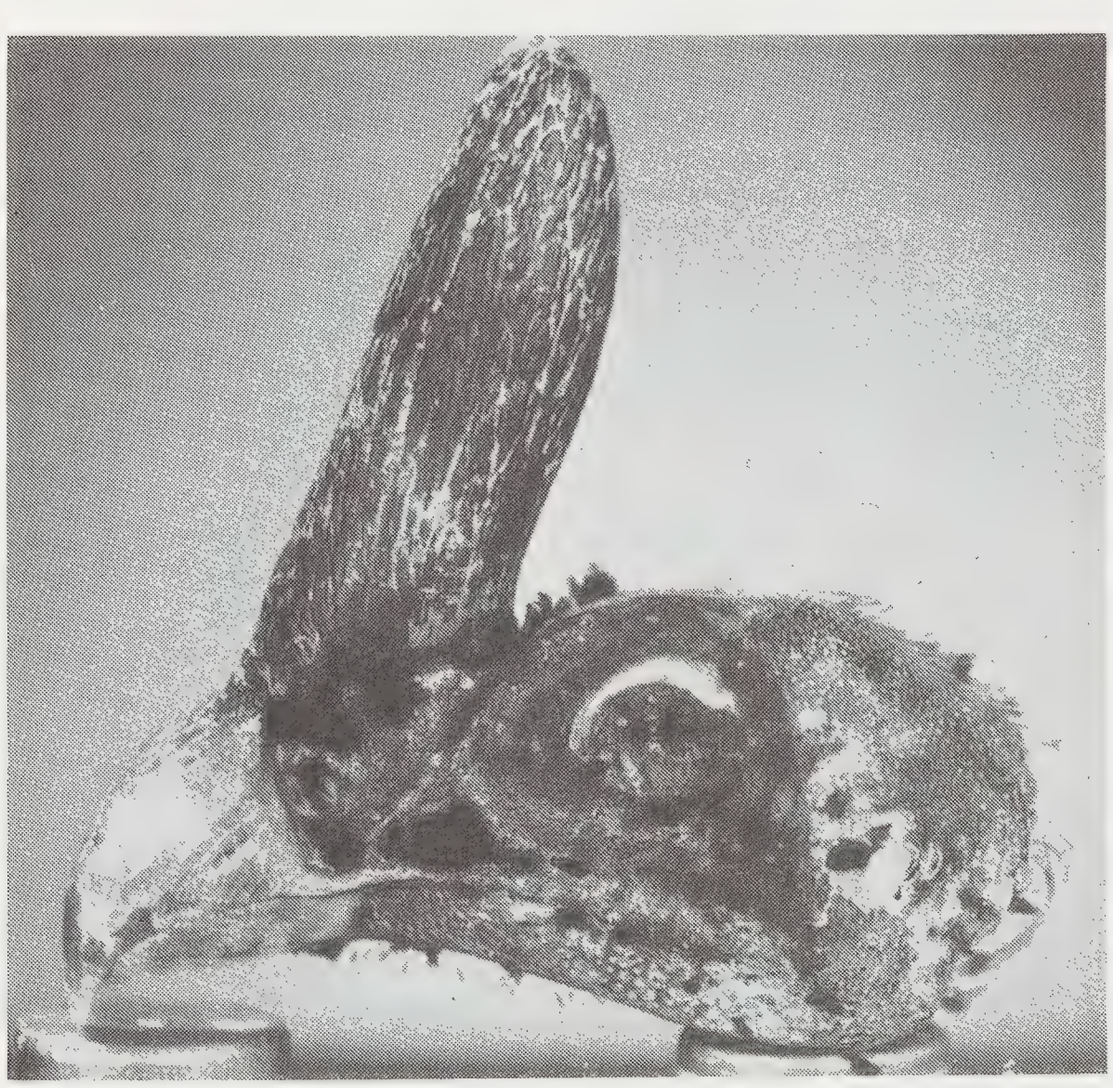
Metamorphosis, for the most part, takes place in July and August. The event is marked by the reduction of the external gills and the loss of the fin on the tail and back. Behaviorally, the energetic larva leaves its aquatic home and ventures forth a handsome but sluggish terrestrial form. It also leaves behind the best understood segment of its life history.

(Part II will appear in a later issue.)

The marbled salamander deposits its eggs in the leaf mould.

The Quest for the Horned Curassow

by Charles Cordier



The horned curassow has a solid projection atop its bill. It is among the least-known of birds.

The curassows, turkey-size ground birds, are the largest and most striking members of the Cracidae, a New World family of fowl that also includes the guans and chachalacas. All seven species of curassows are, for the most part, tropical-forest dwellers that feed on the ground, but head for the trees when disturbed and to roost at night. Curassows are crested, with curved feathers on the head, and have a bill of orange or yellow that in some species is topped by a fleshy or solid projection.

One of the latter species, appropriately called the horned curassow *(Pauxi unicornis)* is among the least-known of all tropical American birds. It originally was described three decades ago on the basis of two skins collected in 1937 near Palmar, Bolivia, 2,500 feet high in the foothills of the Andes.

While visiting the United States in 1965, I was fortunate to see these skins, which are in the collection of Bolivian birds of the Academy of Natural Sciences, Philadelphia, Pennsylvania. At that time I vowed to collect the horned curassow alive — a pledge to myself that was to lead to several arduous treks into the Bolivian hills.

The horned curassow, which reaches a weight of about eight pounds, is largely black in color, with a bluish, tubular casque on its bill. It is very similar to a curassow of Venezuela, the helmeted curassow *(Pauxi pauxi),* except that this bird's casque is fig-shaped. Actually, some authorities think that both curassows are subspecies of the same bird, an opinion that will have some weight if intermediate races are found in the 1,200 miles of country that separate the range of the Venezuela curassow from that of the Bolivian bird. Interest in this possibility has been piqued by the recent finding that the range of the helmeted curassow extends into extreme northeastern Colombia, and the discovery last year in southeastern Peru of a specimen of horned curassow, its horn oval instead of tubular.

It is remarkable that in a country so well

Author Charles Cordier (right) and an Indian chief hold a pair of razor-billed curassows that the chief and his son (left) exchanged for a large aluminum pot (foreground), a machete, and an axe.

explored as Bolivia that the horned curassow could remain unknown to science until 1937 – and even more so that the bird still is seen so seldom by ornithologists.

However, in June 1969, two horned curassows were captured by a highway crew in recently-opened territory about 1,500 feet up in the Andean foothills. A "surazo," a very cold southern wind accompanied by heavy rain, was blowing when the road workers spotted the birds perched in a tree. The workers felled the tree and captured the drenched birds, which, unfortunately, died because of improper care.

Then, in July 1969, after two years of planning, I received a single horned curassow, which was obtained from an isolated Indian village. The specimen was sent to the Frankfurt (Germany) Zoo, where, to my knowledge, it still resides.

Mariano, an elderly, amiable Yura Indian who spoke no Quechua but fairly-fluent Spanish, had known of the existence of two tame curassows in a distant Yura settlement. It took a long time before he decided to undertake the most difficult and unpleasant journey to the village. However, when an exceptionally dry spell reduced the level of water in the many rivers he had to cross, Mariano and a relative set out, loaded with barter goods: aluminim pots, knives, and material for mosquito-netting. It was foreseen it would take two days to reach the Indian settlement. They had planned to begin the two-day return trip after one day of rest, but instead, they hurried back as if possessed. Mariano's companion slipped and fell on one of the birds, and it died. The Indian village chief and his son accompanied them, carrying a pair of razor-billed curassows, a parrot, bows, and arrows for barter. To remain in their good graces, I had to take the razor-billed curassows. We arranged that next year they should try to bring us a few more horned curassows, but they took pains to point out that coming across curassows is a rare happening.

Generally a bird of hilly country, the horned curassow inhabits densely forested regions of heavy rainfall, preferably at altitudes of between about 1,500 feet and 3,600 feet. The Yuracares Indians of the plains adjacent to the Andean foothills know the horned curassow as the "pelischtro" and, if asked where to find it, invariably will point to the Andes. It is possible, however, that the bird once lived on the plains at the fringes of the hills, but was driven out by settlers.

The hill-country home of the horned curassow has extremely rugged terrain, drained by white-water mountain streams. It is cut by steep valleys that lead from the frigid eastern fringe of the Andes toward the alluvial plains that drain northward into the Amazon.

The valleys, or "yungas," have been settled by Quechua-speaking Indians from the highlands. The higher elevations of the valleys, just below the frost-line, are suitable for the cultivation of peppers, while lower areas serve almost exclusively as cocoa plantations. The settlers, who have come from a different region, do not appear interested in the valley fauna (for instance, they have no names for most of the birds around them), except perhaps as game. Both boys and grown men are adept at downing trogons, toucans, and cocks-of-the-rock with sling-shots, while firearms also are used.

Although these conditions do not bode well for the survival of the region's wildlife, the horned curassow probably will persist because of the remoteness of at least some of its habitat.

In September 1969, I managed to reach the end of one of these valleys, which was bounded by an impassable river-gorge. The altitude of the valley was about 3,280 feet, and as I talked with the few settlers living there, I was told that the valley, some years back, had harbored lots of peccaries. Professional hunters had come in and had exterminated these little wild pigs, and at the same time the number of curassows in the valley also had declined. Probably the birds had profited from the presence of the pigs, which opened up the forest

floor, normally very dense on the slopes.

One of the major foods of the curassow consists of the hard-shelled nut of a stately forest-tree called "almendrillo," or almond-tree. After the nut has fallen to the ground, the shell disintegrates, and the birds can get at the seeds within. I have found these seeds in the stomach of a freshly-killed curassow. The almond-tree usually is left standing when settlers clear the ground because the wood is so dense that an axe striking it heats up and loses its temper.

I had been in touch with settlers of the yungas of Totora on many occasions, and they had identified my curassow bills as belonging to the "bitichi de tubo," another local name for the horned curassow, from whose horn they fashion cigarette lighters.

With two helpers, I departed on mule-back on the first leg of the four-hour journey into the valley. One of my men took it upon himself to pull my mule as he scrambled faster and faster down that rocky slope. I had to dismount to traverse the worst stretches on foot. Further into the valley, the overhanging vegetation became very difficult to evade, but my guide made no move to cut the worst with his machete. As I jackknifed in the saddle and tried to shove some vegetation away with one hand, the inside of my palm was hooked by a spiny bamboo, which caused a deep nasty cut with jagged edges.

We had gone ahead so quickly that no pack-mules reached us that day. I nursed my hand, which I had bandaged with a clean handkerchief. We passed the night in an abandoned settler's shack; several other travelers drifted in as the evening passed, until the floor was crowded. My fellow travelers made themselves comfortable with blankets, which people here usually carry under the pack-saddle of a mule. Because our pack-mules had not arrived, however, I sat on a wooden floor leaning against the wall, and toward morning I was miserable with cold.

We resumed our trip the next morning over a most abominable trail. As we made a noontime stop, a pack-mule reached us, and we had our first bite to eat in 24 hours. Unfortunately, the mule carrying medical supplies had died on the trail, and my hand went without medication until the supplies were delivered two days later.

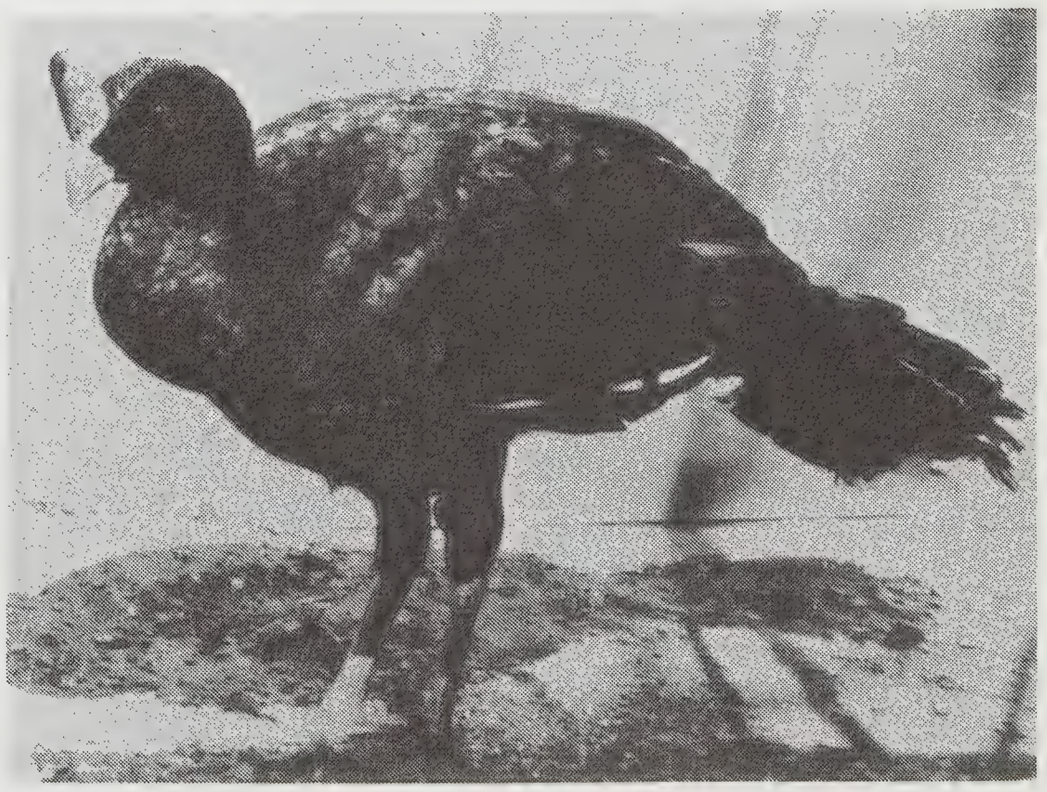
Toward evening we reached El Guanay, the end of our journey and also the terminal of the mule-track. Further on, I was told, no trail existed, and frequent landslides occurred in the area, obliterating the trails. From El Guanay, after a day's walk along the bed of a river, one could reach Carmen-Pampa, where "bitichis de tubo" were said to be as tame as chickens. We had hardly dismounted when, below some huge trees on the slope toward the river, a magnificent cock-of-the-rock alighted in a fruit tree. Moments later it was joined by an Amazonian umbrellabird. My two helpers strung up a net and by the next day we secured both birds. I then dispatched my two helpers, guided by a local hunter, toward Carmen-Pampa to do a preliminary survey about the possibilities of capturing curassows there.

After five days, my men were back from Carmen-Pampa. They had not seen a curassow on the trek to Carmen-Pampa, but had the impression the birds, although wary, were in the area. On the way back, two hours' walk from our camp, they saw one and, contrary to my orders, shot it. I was in no position to make a skin, which would have been most valuable scientifically. We then talked about the possibilities of establishing camp another day's walk from Carmen-Pampa, but we decided we could not carry in enough food to last three men 45 days and, moreover, could not have carried out birds we might have collected.

The last horned curassow I have seen prior to writing this article was, in December 1969, captive in the compound of a missionary. He told me how he had obtained two birds at great cost and physical exertion. However, one already had been lost or stolen.

Although they are rare, horned curassows can be obtained. I shall never rest until I find a secluded spot where these birds are unafraid and numerous, and where I can collect some specimens for exhibition and captive breeding programs in zoos.

The horned curassow inhabits the rugged foothills of the Bolivian Andes.



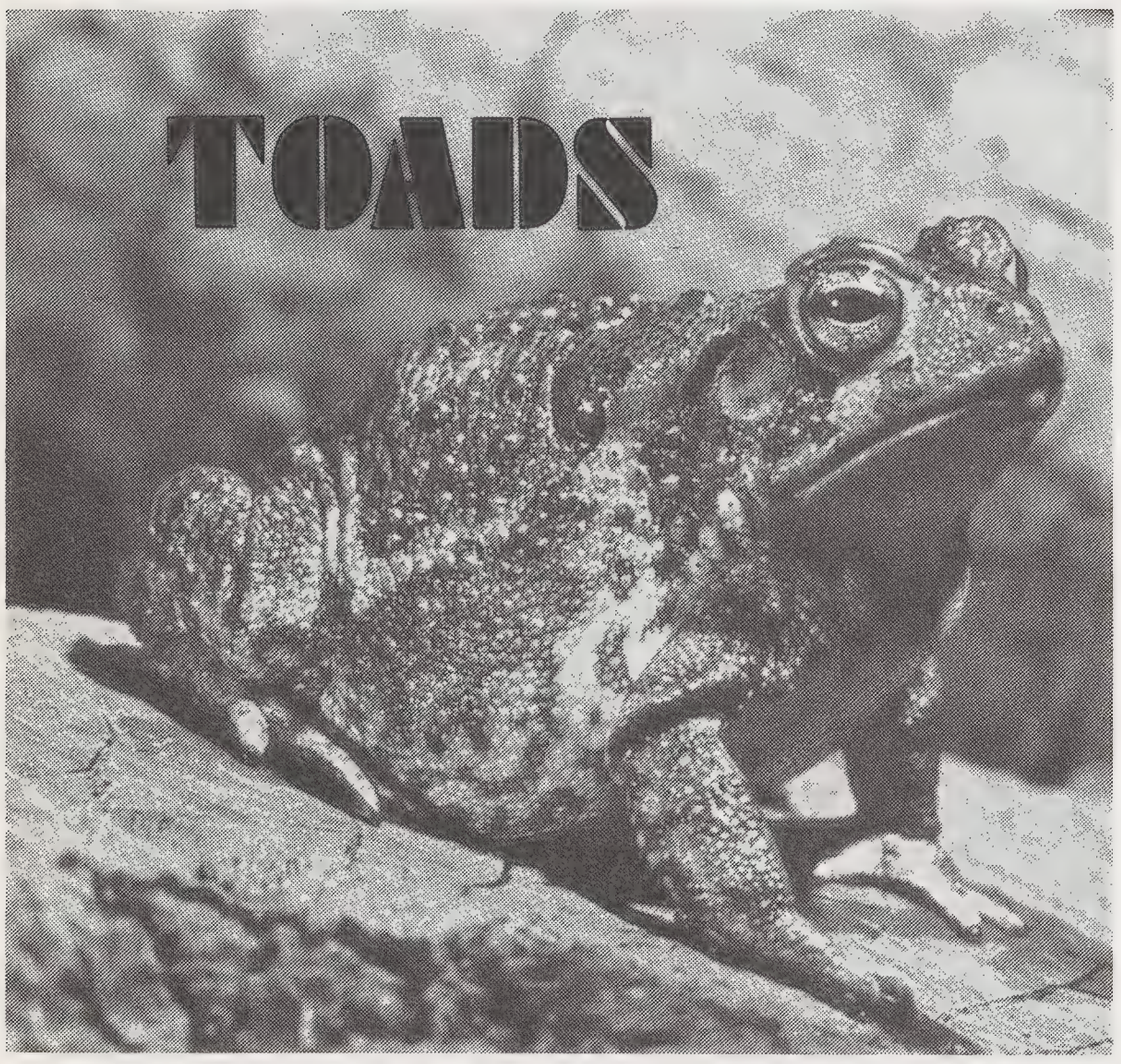
FROGS

The giant free-toed frog of Haiti has no webbing between its toes. It often climbs on low bushes.

AND

OPPOSITE: The Cuban treefrog is extremely vocal. It was introduced in Florida from Cuba.

TOADS



The Colorado River toad of the Southwest often reaches 7 inches in length.

from Around the World

The Asian horned frog's "horns" are merely skin flaps, projections of the edge of the upper eyelid.

Photographs by Bill Meng

The "horn" of the Asian horned frog is not at all sharp or hard.

The southern toad is found from Virginia southward through Florida and west to the Mississippi River.

The African toad ranges throughout the continent, except for rain forest and desert regions.

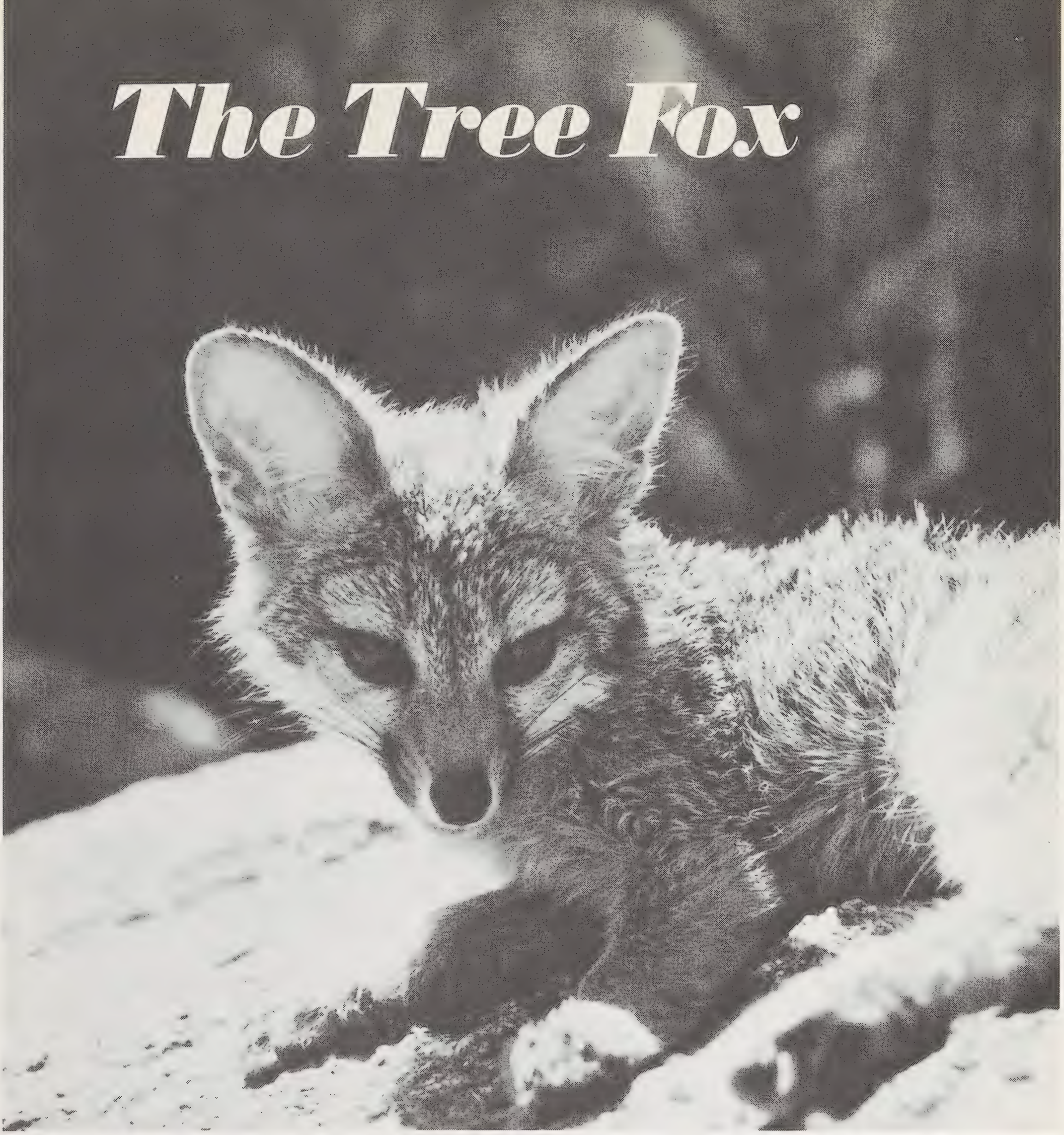
Heilpern's treefrog is a native of Haiti.

The beautiful treefrog of Mexico and Central America is green with red eyes.

The Columbian arrow poison frog is red, green, yellow, and black. Indians extract venom from skin glands of the frog and use it on the tips of their arrows.

The vivid markings of the red-spotted arrow poison frog are an example of warning coloration.

The Tree Fox



by Frank Turkowski

The gray fox is a New World creature, native to North America. Its range extends into Central America on the south.

The ability to climb trees like a cat and a taste for scorpions, beans, and berries seem unlikely attributes for a fox, but they are some of the characteristics that make the gray fox a fascinating member of the wildlife community.

I had the chance to study this common but seldom seen animal while working on my doctoral dissertation in zoology. The gray fox is extremely nimble and adept at climbing trees. In fact, in some parts of the country it is called the tree fox. A gray fox can shinny up a tree or move from branch to branch with as much grace as a cat.

Once I saw a gray fox climb a tree trunk two feet in diameter. A pair that I observed – which raised its family in an abandoned winery – ran on fence tops that were one-and-a-half inches wide and walked on an inclined four-inch pipe crossing between wine vats 15 feet above ground. Another gray fox, frightened by a dog, climbed a pinon tree and crawled on branches smaller in diameter than a person's finger.

During my study, I captured foxes alive by using traps equipped with tranquilizer tabs. When a fox was trapped, it chewed the drug-filled tab

The Gray Fox Climbs in a Most Unlikely Fashion

and fell asleep, uninjured. A friend and I once searched for a trapped fox for several hours without finding a trace of it. We almost had decided that it had flown away, when we looked up into a tree and saw the trap chain and drag hook. The fox was dangling where it had climbed, ten feet above the ground. It was fast asleep.

The general appearance of gray foxes is similar to that of other fox species. They have long snouts, relatively short legs, and bushy tails. Adult gray foxes weigh from five pounds to eleven pounds and are about a foot tall at the shoulder. The coat of the adult is grizzled salt-and-pepper gray with white underparts. The sides of the head and neck are rust-colored. The black-tipped tail has a black stripe on its upper surface. In some individuals, the stripe runs down the middle of the back.

The gray fox is a native of the New World and lives in Central America, Mexico, and most of the United States, except for the Northwest and some of the Plains States. Usually it prefers forested, bushy, or rocky habitats. Two other species of fox inhabit the continental United States: the red fox, slightly larger than the gray; and the kit fox, which weighs about five pounds. Rust, tawny, or red, as its name implies, with white-tipped tail, the red fox is what most people picture as a typical fox. The kit fox has a buff-colored coat, prominent ears, and a black-tipped tail and resembles a miniature coyote.

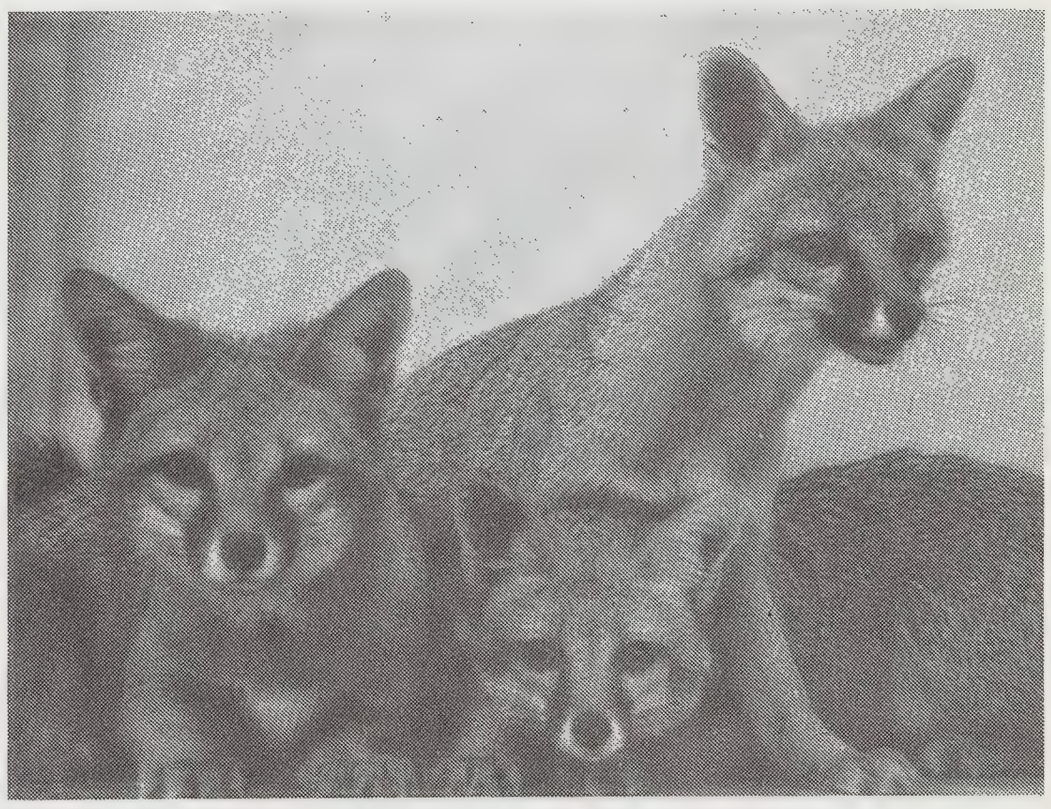
The life cycle of gray foxes begins with the birth of a litter of up to ten pups, though litters of three to five occur most often. The pups are born in the spring after a 60-day gestation period. At birth, they have short gray fur, and their eyes and ears are closed.

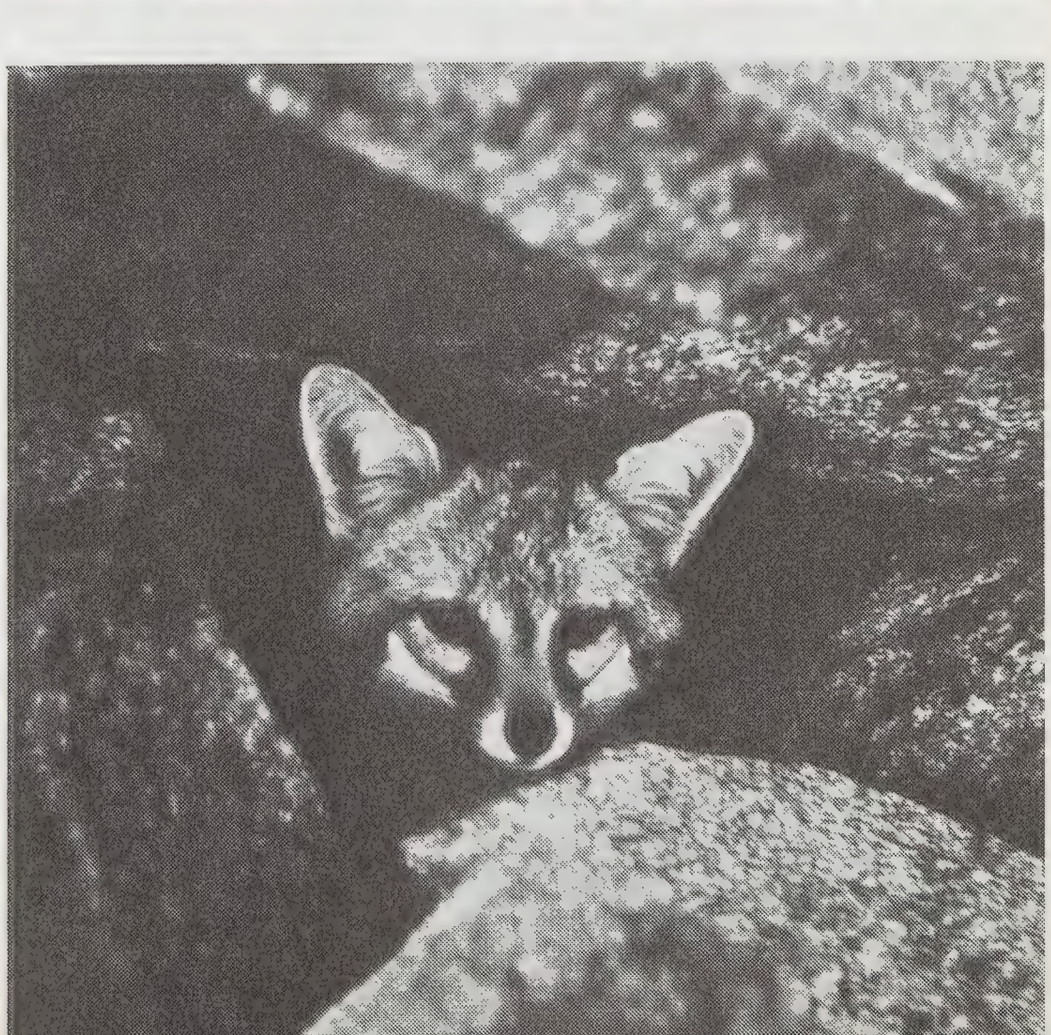
The den usually is located among the shelter of large boulders or under a bush or tree. Both parents care for the young and attempt to protect them. When intruders are near the den, the parents bark and even attempt to lead them away. I once saw an adult gray fox trying to decoy human intruders away from a den with pups by feigning an injured leg.

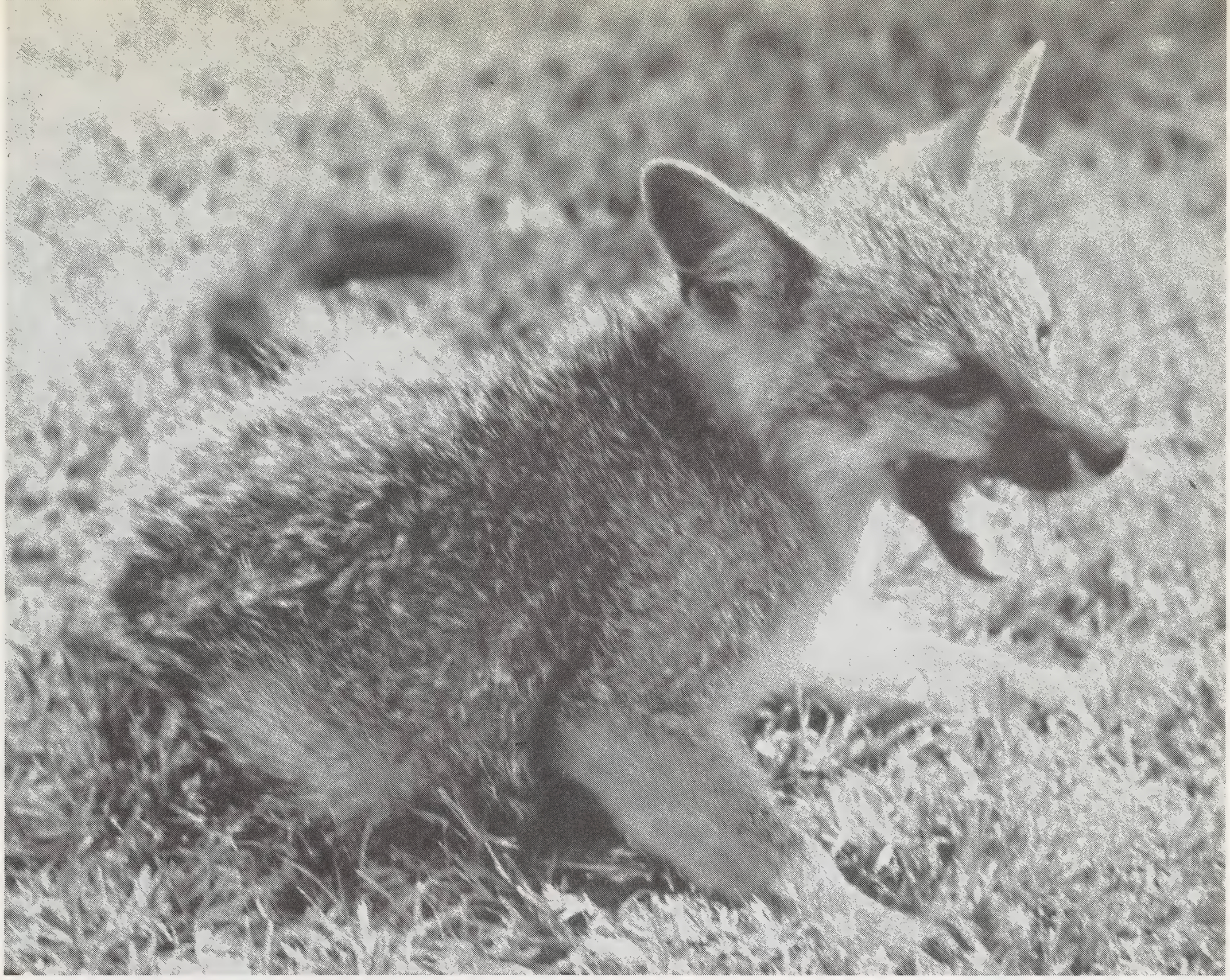
As the young grow, they begin to eat solid foods. They stay near the den and supplement their diet of mother's milk with insects or foods brought by their parents. Capturing grasshoppers and beetles near the den probably helps prepare the young for hunting larger animals later on.

Like many wild canines, gray foxes have a varied diet. To determine their food habits, I examined digestive-tract contents of gray foxes collected from the Lower Sonoran Desert and from oak and pinion-juniper habitats of the southwestern United States. The study showed that though gray foxes are meat-eaters, they also like their vegetables. They take foods that are available locally or seasonally. On a yearly basis, 65 percent of the desert foxes examined had mammals in their diets. Birds were eaten by 21 percent; reptiles by 11 percent; arthropods (in-

Gray fox young are born in a burrow sheltered by boulders, or under a bush or tree.







The gray fox kept by the author for study growled in mock fighting but never bit the author with any force.

sects, scorpions, spiders, etc.) by 56 percent; and plants by 39 percent.

Mammals were eaten most frequently from January through June. Pocket mice, wood rats, and kangaroo rats were important in the foxes' diet, while ground squirrels, white-footed mice, and rabbits were less so.

During the denning season, the diet is more varied. At this time there is an increased need for energy by the growing pups. The study showed that more birds, mostly small perching species, were eaten from March to June, but these were not an important food when foxes were not denning. Snakes and lizards rarely occurred in the diet during the winter months, but they were commonly eaten during May and June, as were arthropods and plants.

The increase in arthropod and plant food in spring is probably more than a reflection of availability. Experiments suggest that plant and insect foods may be necessary to provide moisture for foxes during dry months when free water is not available on the desert. Grasshoppers, beetles, spiders, scorpions, and centipedes were the arthropods most frequently eaten by the foxes under study. Most foxes that had eaten scorpions and centipedes had consumed these along with their poison glands and stingers.

Grasses were eaten by many foxes, but mesquite beans, which ripen in the fall, were an important source of food from June to October. The diets of foxes from oak and pinon-juniper habitats were generally similar to those of the desert foxes. In fact, although the prey species may vary according to region and habitat, the overall diet of grey foxes is similar throughout the country.

One of the foxes I studied became very used to me and acted quite tame if allowed to go his own way. At times I would tussle with him in a mock fight. Although he growled, he never once bit hard. Indoors he often hid beneath furniture and leaped on my back when I turned away or passed him.

My fox learned to come when I whistled and also learned the meaning of the word "no," since I conditioned him by reprimanding him when I said it. Sometimes he would disregard my command and continue chewing on a piece of furniture or

similar mischief. However, he kept an eye on me until I moved toward him, then ran away with his bushy tail trailing behind him. He crawled under furniture and growled when he did not want to be handled. Whenever I returned home after a brief absence, he displayed greeting behavior, emitting a series of short whimpers and approaching with his body low, his ears pointed back, and his tail wagging.

Like most canines, gray foxes bury food, which may be eaten later if their prey becomes scarce. If I approached a buried food cache of my tame fox, he watched intently until I was near, then removed the food, and carried it in his mouth until I left; then he buried it again, sometimes in another place.

Gray foxes have a coarse bark which terminates with increased volume. The sound is very loud and suggests the voice of a much larger animal. The first time I heard a gray fox bark was at night and I though the sound came from an animal at least as large as a puma. I have also heard them whimper and give warning growls. Once, I ignored a growl and have a scar on my finger to prove it.

Since foxes have relatively short legs, they usually do not travel great distances when hunting, as coyotes and wolves do. Studies of Florida gray foxes indicated they had a home range of two square miles. Gray foxes are fairly short-winded, but can run at top speeds of about 25 miles per hour.

Gray foxes appear to be more abundant on farmlands than in totally wild areas, and it is probable that cultivation of the land has increased fox populations. This may be because pocket gophers, ground squirrels, and rabbits tend to increase near cultivated fields.

The gray fox is not valued as a game animal or fur bearer. This, of course, is a factor in favor of the survival of this wild dog that rivals the cats in the trees.

The gray fox, although active and nimble, has a relatively small home range. Studies of the species in Florida indicated the foxes there had home ranges of two square miles.

Species

Pollution

Introduced Animals and the Balance of Nature

by

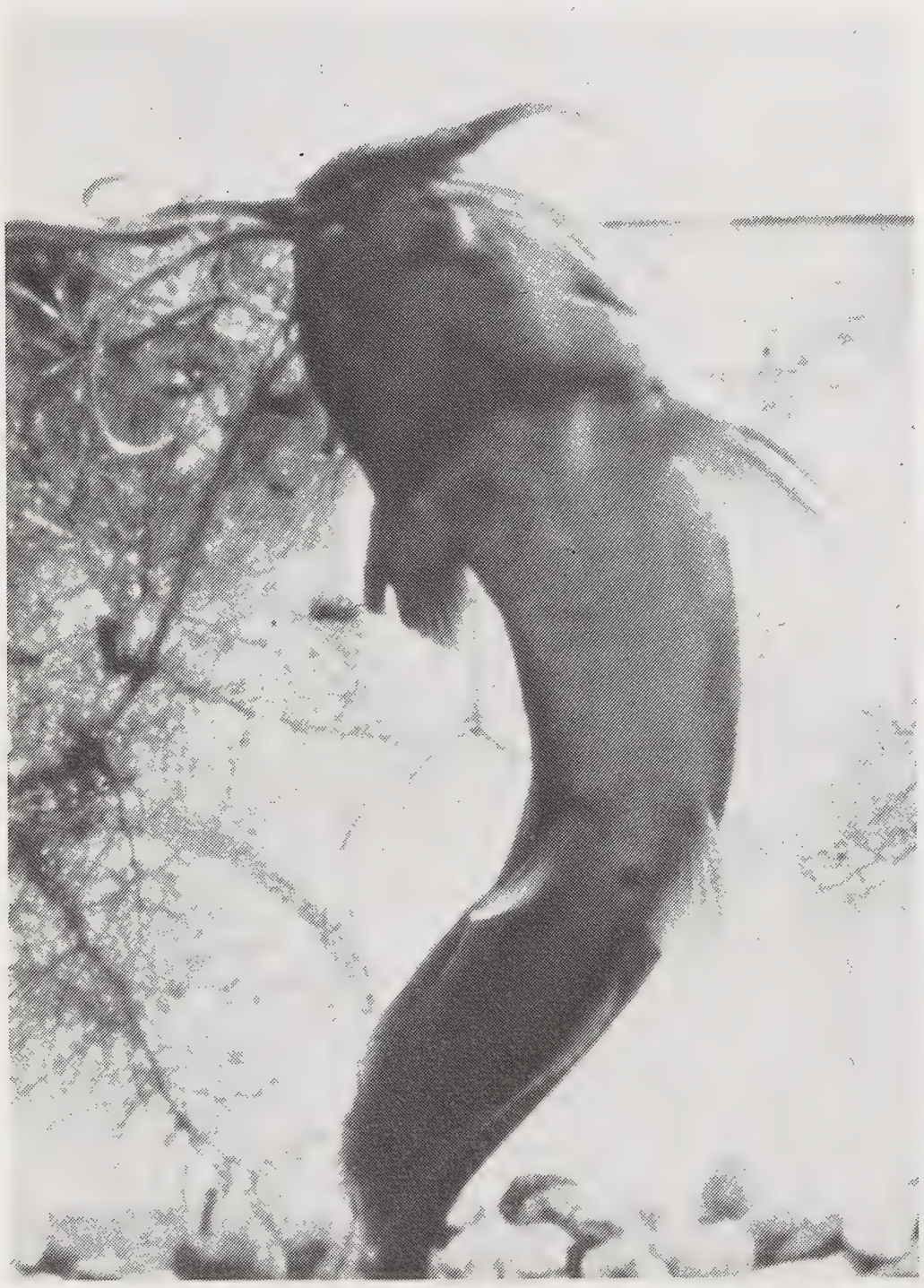
Walter R. Courtenay, Jr. and Vernon E. Ogilvie

Man's curiosity and admiration of the exotic and bizarre, along with his natural collecting instincts, have resulted in the introduction of many non-native plants and animals to various parts of our planet. Gathering and transport of living plants and animals probably began in very ancient times, even before the time of Noah and his ark, and today the traffic, in live wild animals particularly, has reached astronomical proportions.

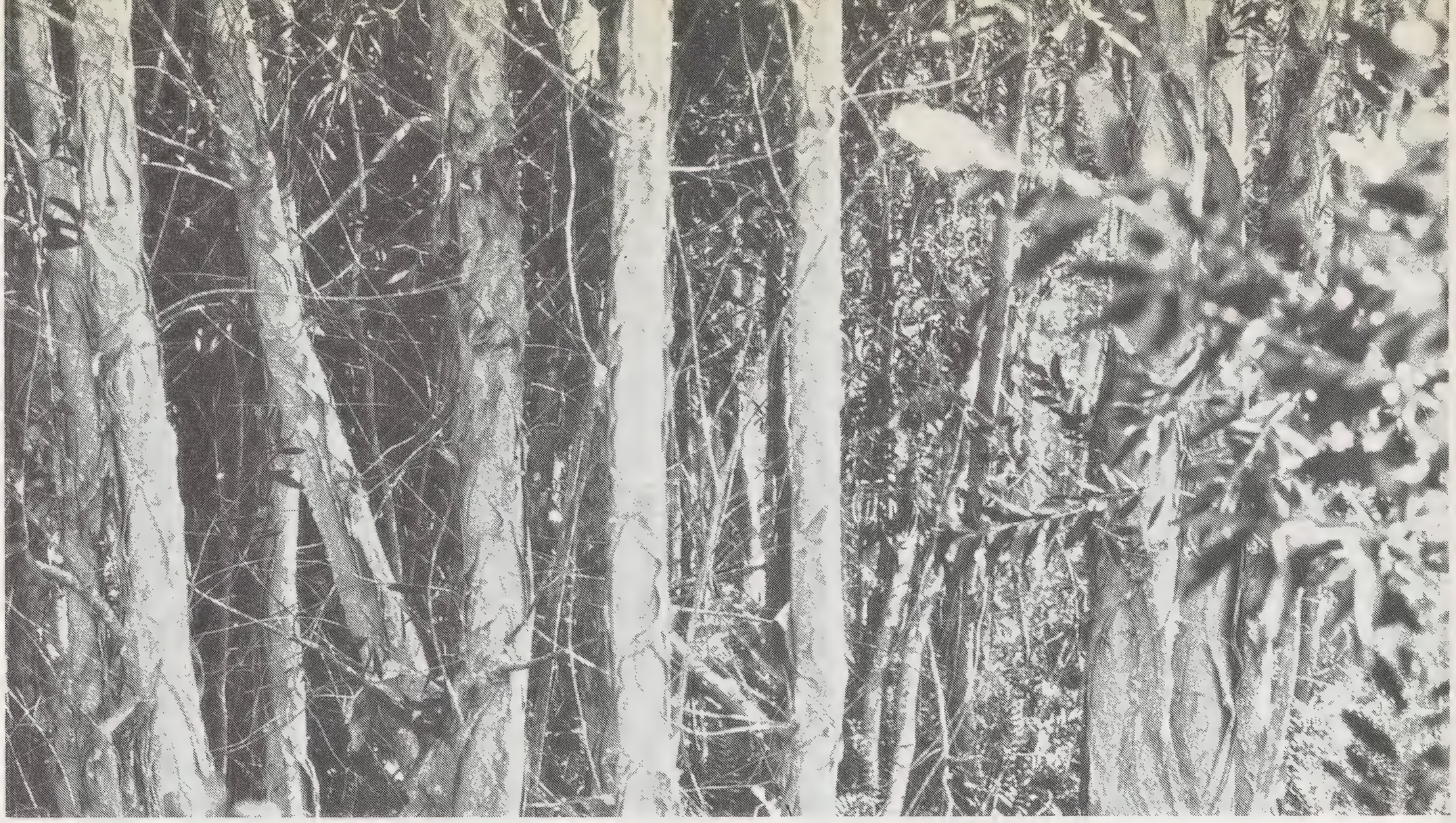
The tropical fish that people keep in home aquariums, the exotic lizards and other reptiles offered in pet shops, and spectacular landscaping with foreign plants are some of the results of this trade. Too often, either accidentally or on purpose, these plant and animal imports become part of our natural environment, a situation that sometimes has serious repercussions. So far introductions of exotic organisms into the United States have involved plants and animals that live on land or in freshwater.

New residents and tourists in south Florida often admire the stately appearance and massive size of the Australian pine, which actually is not a pine but an introduced species of South Sea island tree related to the orchid tree and the pepper tree. This tree has a phenomenal growth rate and, in some areas, is replacing native vegetation. The Australian pine has a massive root system and is very resistant to salt water. In certain areas along the Atlantic and Gulf coasts, the dense roots of this tree have thwarted nesting attempts of sea turtles.

Another exotic plant now established in Florida is the melaleuca, a tree with corky bark, lush



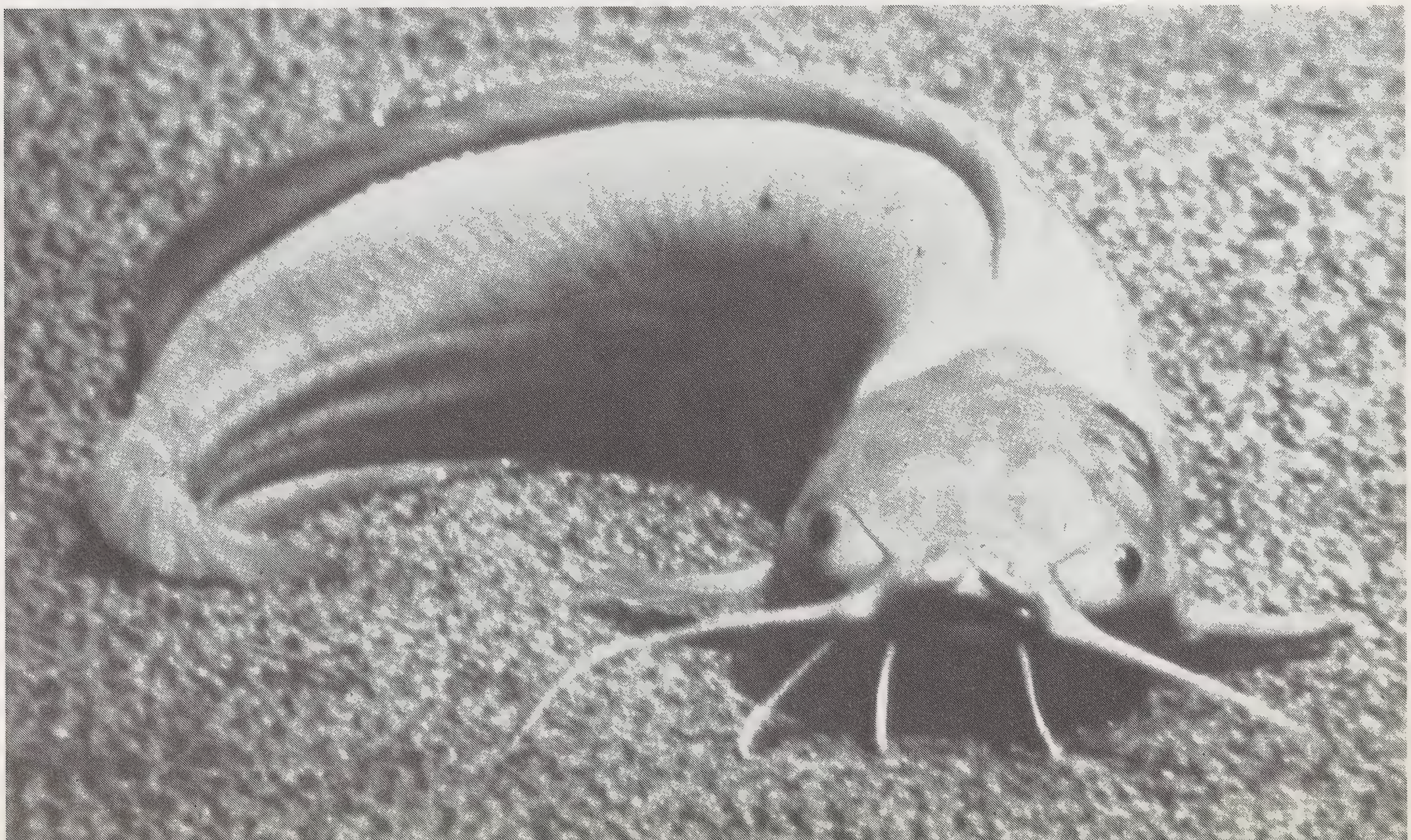
The walking catfish, left, and the Australian pine, right, are examples of introduced species that have created ecological problems in Florida.



The melaleuca, introduced into Florida, is encroaching on the native cypress trees.

Although the water hyacinth is an attractive plant, it has become a major nuisance in Florida, where it was introduced. It clogs canals and waterways through much of the State.

One of the latest introduced pests in Florida is the so-called walking catfish. Originally a native of Southeast Asia, this fish has organs that enable it to breathe air.



foliage, and highly irritating pollen. This tree originally was introduced in Florida so that its bark could be used commercially as insulation material in shipping boxes. Later, drainage of south Florida swamps caused concern that cypress might not survive and that deer populations might be reduced as a result of this lack of cover. As an attempted solution to this problem, melaleuca seeds were sown by air in many areas of south Florida. Today melaleuca are actively encroaching on established native cypress, and deer avoid stands of this tree and refuse to feed on its leaves, even when faced with starvation.

The starling, the English sparrow, and the carp are examples of animal introductions which have become serious pests. When these animals were brought to North America from Europe, the problems that have resulted from their introduction were not envisioned. This certainly must have been the case when a lady from Florida, who admired the South American water hyacinth at an international exposition in New Orleans prior to the turn of the century, brought several of the plants home and put them in local waters. The hyacinth spread rapidly through Florida's waterways, and today clogs canals and streams through much of the state. Eradication programs directed toward this pest, all of which have been only temporarily effective, have cost millions of dollars.

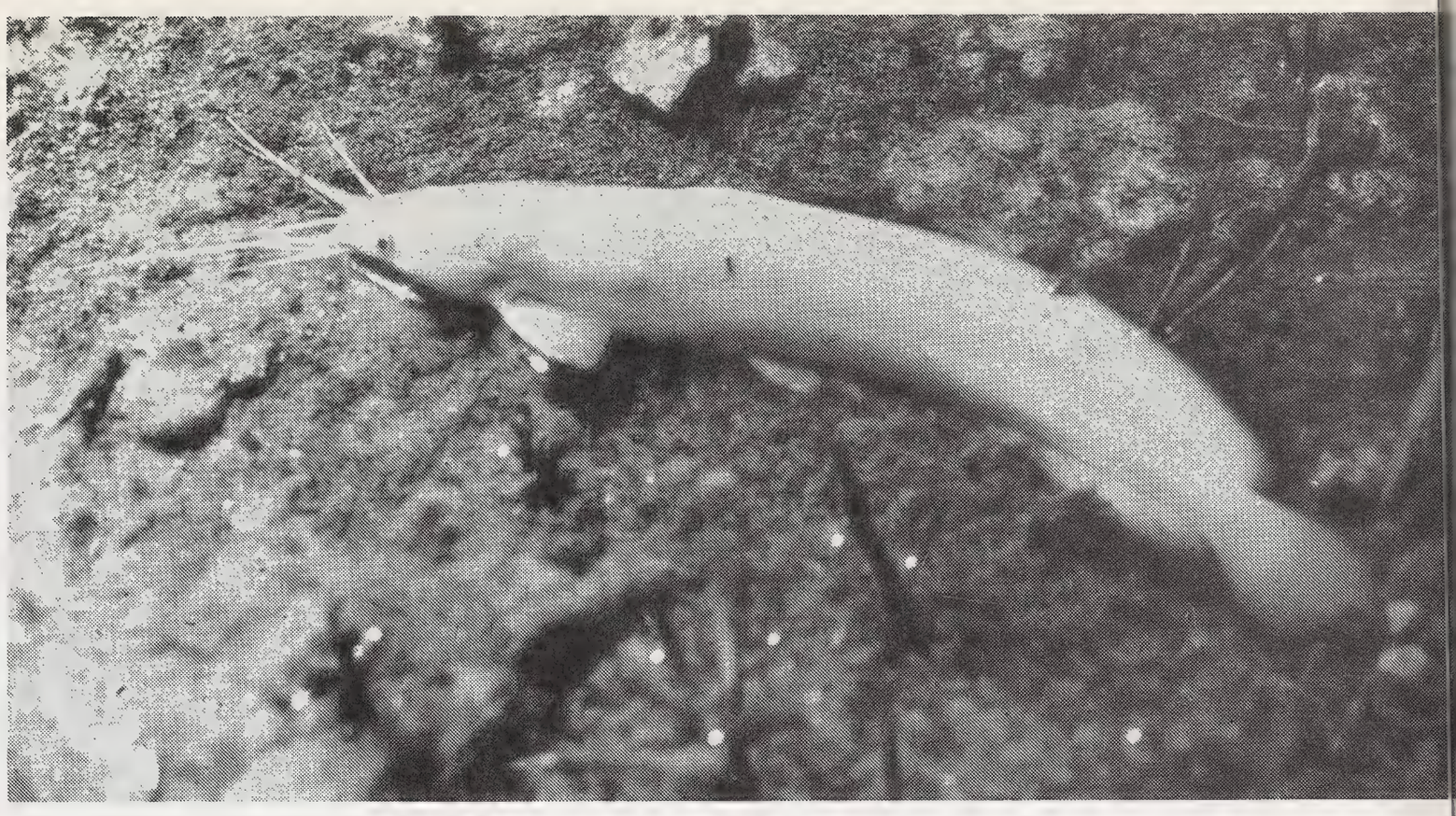
Probably the most well-known recent introduction to Florida's fauna is the so-called walking catfish. In 1961, an article entitled *Die Albinishe Clariden* appeared in a German aquarist trade journal. As a result, a species of catfish, native to Southeast Asia and occurring naturally as an albino, was imported as a curiosity for sale in the United States. Many of these fish, which are able to breathe air and crawl on land, escaped from a tropical "fish farm" west of Deerfield Beach into the gridwork of drainage canals that covers south Florida. With abundant food and no natural enemies in this new environment, the catfish multiplied and spread rapidly over two counties. When a long drought was broken in May 1968 by torrential rains, thousands of these catfish began their natural mass migrations and frequently were seen by humans. The fish crawled across major roads, ambled about on lawns, and swam in shallow puddles several miles from the nearest pond or canal. The news media dubbed the fish the walking catfish and spread word of its introduction over the world. Stories were circulated that this fish attacked dogs which, in fact, is untrue. A related African species, however, is known to eat young crocodiles.

The species involved in Florida is *Clarias batrachus,* imported from Thailand. In some respects the walking catfish resembles our native catfishes with three notable exceptions: the dorsal fin is continuous from its origin behind the head, and reaches almost to the tail, which gives the fish an eel-like appearance; the pectoral fins possess strong, sharp spines, whereas our native catfishes also have such a spine at the origin of the dorsal fin as well as the pectorals; and in albino, or white, walking catfishes, the roof of the skull can be seen beneath the skin as a slightly copper-colored, sculptured, flattened plate of bone, whereas the dark or "natural" specimens more closely resemble native bullheads except for the elongated body and dorsal fin.

In Southeast Asia, sharp potential population increases of this fish are controlled by the length and severity of drought conditions. Although these fish can breathe air, they are killed by drying-out. On occasion, walking catfish will bury themselves in mud to withstand severe droughts. (In parts of Africa, people "fish" for catfish by thumping dried mud until they hear a hollow sound. The live fish is then dug from the ground.) In south Florida, droughts are not as lengthy nor as damaging.

Clarias batrachus is only one of many species belonging to the family Clariidae. All of these fishes are capable of breathing air through a specialized, highly-modified lung-like device which is actually a specialized gill. This structure lies behind the other gills within the gill chamber and in life has the general appearance of a leafless red "bush" or minute tree, with many small branches. The aerial breathing device is kept moist by both water and mucous, and gas exchanges occur across its thin walls in a manner similar to that which takes place in our own lungs. As long as this structure remains damp, the fish is capable of using air.

Nearly every fish will flop around when removed from its natural habitat and placed on land. Under such circumstances, the walking catfish will flip its body once or twice to right itself upon its flattened underside and then begin to "walk" away. The movements of the body are snake-like or eel-like, utilizing the strong muscles of the trunk. The tail is employed in a side-to-side sculling motion which alternately supports each side of the body with every flexion. The spines on the pectoral fins are erected and locked into place. By functioning as struts or stabilizers, the spines



The walking catfish travels overland by means of its powerful fins and muscular body. It actually walks, rather than flops around as fish usually do when stranded on dry land.

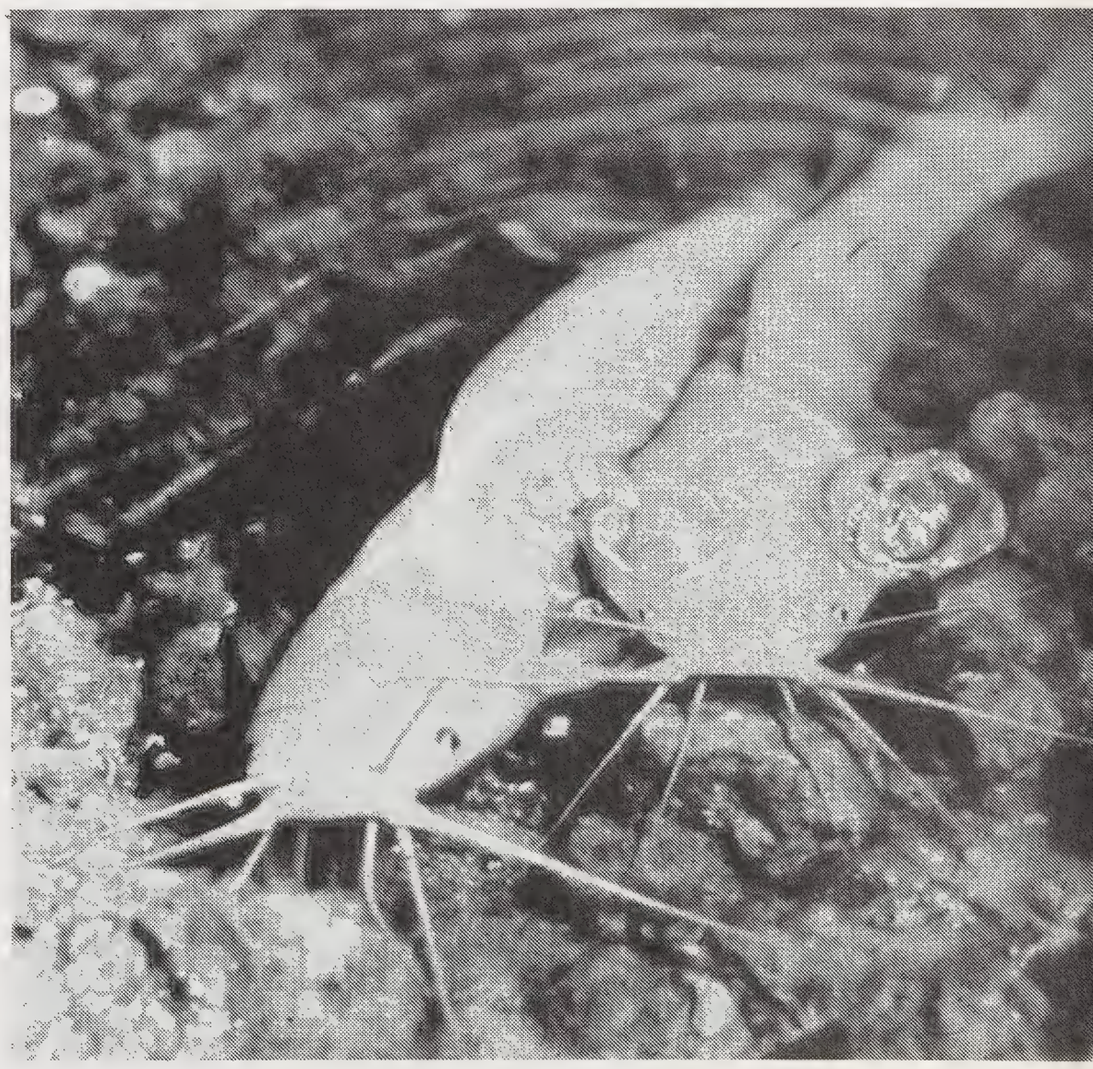
prevent the body from jackknifing with each movement and at the same time, alternately act as anchors to maintain the direction of forward movement.

The walking catfish does not need to be stranded to go for a stroll. During the summer months, especially during periods of heavy rain, individual fish or several hundred at a time will amble across land, lawns, fields, and even major highways to get from one body of water to another. It is suspected that the reason for these overland migrations may be associated with finding suitable spawning areas.

During our wet season, these fish compete directly with native fish for food and space, which has presented a new problem to resident forms. In the "dry" months, when canal and pond waters are reduced by evaporation, the catfish eat everything, including native fish. During these same months, stagnant conditions occur. While native fish die from too little oxygen in isolated places, walking catfish surface and breath air. Their high reproductive capability further increases this threat through potential dominance by numbers alone. Beyond the basic importance of conservation, the walking catfish poses a potentially serious threat to the freshwater sport fisheries of south Florida on which millions of dollars are spend each year. Total eradication of this new resident, unfortunately, is physically and fiscally impossible.

A fellow traveller of the walking catfish is an introduced South American fish, the port cichlid or black acara, *Aequidens portalegrensis.* This fish, a member of the family Cichlidae, may have escaped from a fish farm, as did *Clarias.* While the port cichlid does not breathe air nor walk on land, its spread has been almost as extensive and dramatic as that of the catfish. Little is known of the food preferences of the port cichlid, but it is reproducing successfully and thus may be adding to the crowding effect, which could displace or restrict native fishes. It has been recently found, however, that such native sport fish as tarpon and snook relish the little exotics as a desired food item.

Other introduced cichlids include the oscar, *Astronotus ocellatus,* established near Miami; the jewelfish, *Hemichromis bimaculatus,* in Hialeah; and the firemouth, *Cichlasoma meeki* in Miami



Walking catfish compete with native fish for food and space. They also prey on some native fish.

and south of Lake Worth. At least two species of South American armored catfishes, *Hypostomus plecostomus* and *Callichthys callichthys,* have been captured in south Florida canals. A recent collection of fish near Lake Worth yielded 32 species, 15 of which were introduced exotics.

According to the United States Department of the Interior, over 64 million fish were imported into this country in 1968, most for the home aquarium trade. Over 41 million of these fish entered North America through the Florida ports of Miami and Tampa.

When a walking catfish pond is poisoned to control the fish, they walk overland to other ponds and waterways.

Many of these are species which have never been studied or described and, hence, are unknown to science. All may harbor exotic parasites, bacteria, and viruses which, if established, could present a serious threat to native fish. Moreover, introduced organisms do not respect man-made state boundaries and, therefore, the escape regulations imposed by any one state agency lack effectiveness.

Federal statutes are necessary to reduce or, hopefully, eliminate accidental introductions from inadequately secured fish farms. A national program, directed toward the home aquarist, is needed to educate the public against dumping of unwanted fish. A panel of experts consisting of scientists, tradesmen, and other representatives of concerned agencies must be established to consider the advisability of purposeful introductions of non-indigenous organisms which could destroy valuable natural resources.

Besides fish, Florida has now provided a welcome home to such terrestrial mammalian exotics as monkeys, armadillos, jaguarundi, and ocelot. The South American caiman lizard, which may pose a threat to the dwindling stocks of alligators, is also established. The giant toad, *Bufo marinus,* has been in south Florida since the 1950s and has been cited as a serious danger to dogs and cats. When dogs and cats mouth these toads, their deadly poison glands in the skin can be punctured. South Florida is becoming more like South America, Southeast Asia, and Africa in flora and fauna every day. For each introduction one or more native forms must give up some food, territory, freedom, and, possibly, continued existence.

Can this also happen in the marine environment? Those of us who are marine scientists should learn from the examples of damage caused by terrestrial and freshwater introductions of

exotics. Admittedly, very few non-native marine organisms have become established along our coasts. A few small fishes, gobies, introduced from western reaches of the Pacific, are now established along the California coast. A salt-tolerant species of African mouth-brooder, *Tilapia melanotheron,* has been established in the Tampa Bay area of Florida for the past decade. A mollusk, *Siphonaria pectinata,* locally called a false limpet, was introduced to North America from Africa. This air-breathing snail is known to erode beach rock outcroppings, and it is conceivable that it could be a factor in beach erosion in general.

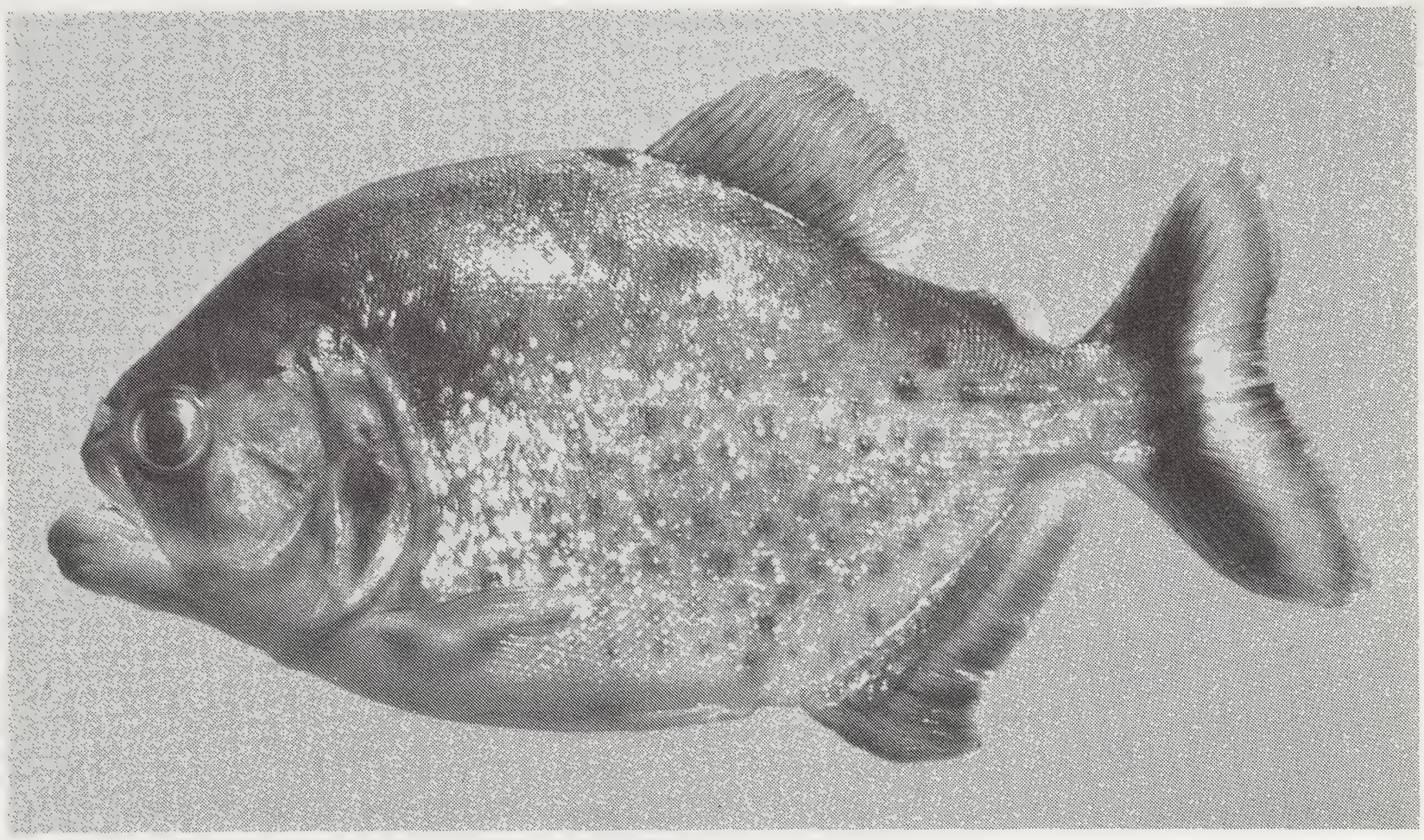
The home aquarium trade has, to date, utilized primarily native marine species. Some exotic forms, such as the clown anemonefish, are now being imported and have the potential of replacing some of our most colorful reef fishes if released. The introduction of the deadly poisonous stonefish could be disastrous.

The greatest potential danger of accidental marine introductions exists not in the aquarium trade but in an emerging industry, mariculture — the farming of commercially important marine organisms. Species of South American oysters and western Pacific shrimps are now being imported for use by mariculture concerns. Some of these have planktonic larvae and, should they become established, could replace or compete heavily with already-reduced populations of native species. If diseases are transported on or within these imports to this country, extant fisheries could be wiped out in a short period of time.

Certainly a great deal of study is needed to assure the prevention of such disasters. What has happened elsewhere can also happen along our coasts. Our present pollution problems are serious enough without compounding the situation.

(*Editor's Note*: For many years Florida biologists have lived in fear of piranhas becoming established in their waters. Two incidents in 1970 served to renew that fear and to add some new food for thought on the subject. According to a recent report by Vernon E. Ogilvie, one piranha has been caught from a canal in south Florida, and two piranha wintered over in a swimming pool in the Miami area during the third coldest winter in history. There is no evidence at present to indicate that piranhas have become established in Florida, but there is evidence that they could do so.)

The piranha, which experts fear could be introduced in Florida, can be seen on exhibit at the New York Aquarium.



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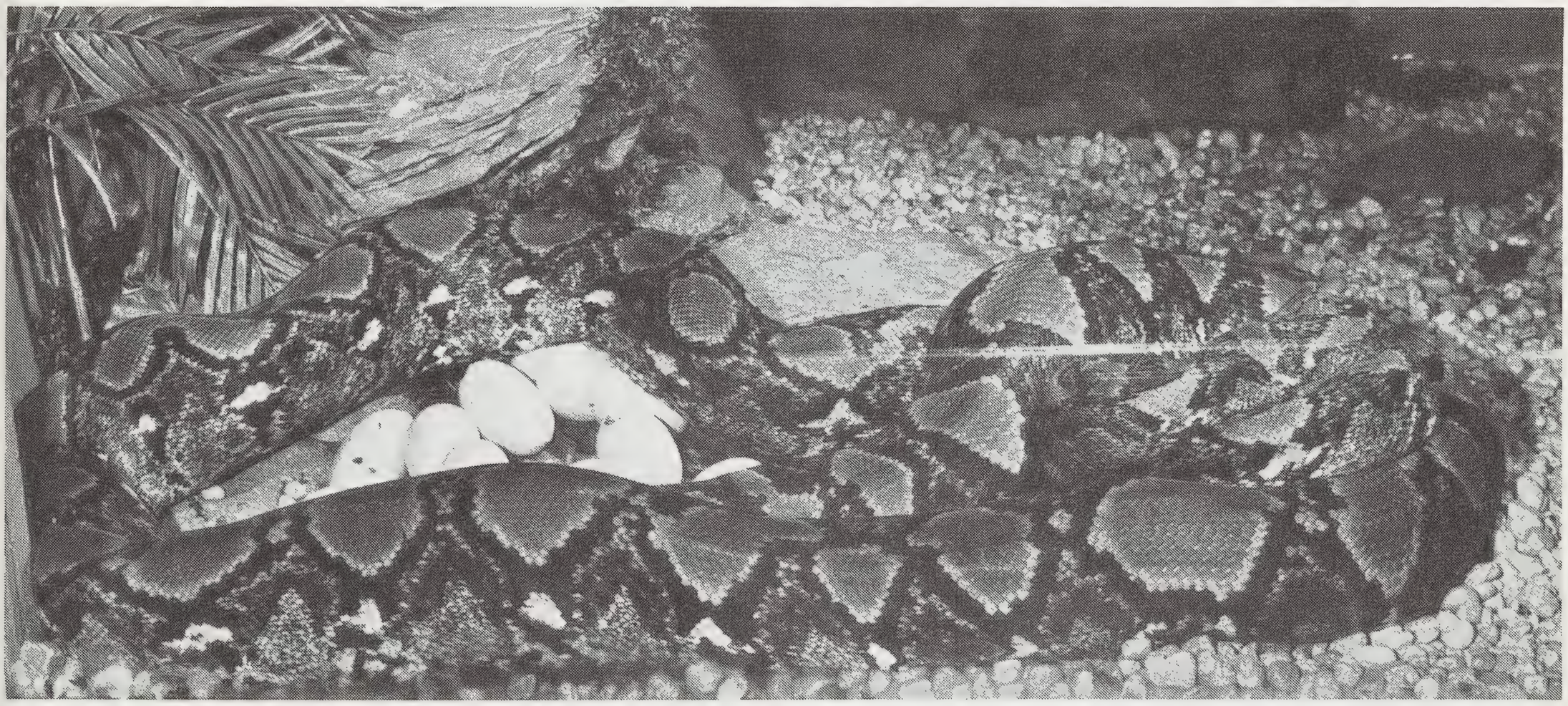

Fifty-two eggs were produced in February at the Bronx Zoo by a female reticulated python, 19 feet long. The reticulated python, a resident of Southeast Asia, is one of the world's largest snakes. It may reach a length of 30 feet.

PYTHON PRODUCES EGG CLUTCH

For the second time in the last three years, a reticulated python has produced a clutch of eggs at the Bronx Zoo. The initial clutch resulted in 22 young, the first zoo-bred reticulated pythons hatched in captivity in the United States. The two clutches were produced by different females.

The present clutch of 52 eggs was laid February 10 and February 11 . The eggs were placed in a bin containing damp sawdust and warmed to 80 degrees F. by a heat lamp. Hatching is expected in three months.

The female that produced the eggs is 19 feet long and on exhibit at the zoo's Reptile House.

SEA GRANT TO OSBORN LABS

The Osborn Laboratories of Marine Sciences, which are operated by the New York Zoological Society, have been awarded a $209,000 Sea Grant for research on anti-bacterial agents from sponges.

The grant was made by the U.S. Commerce Department's National Oceanic and Atmospheric Administration.

In the three-year project, scientists at the laboratories, which are at the New York Aquarium, will attempt to isolate certain substances found in sponges that may have therapeutic value as antibiotics, anti-fungal agents, and metabolic inhibitors.

Under the leadership of the laboratories' director, Dr. Ross F. Nigrelli, and Dr. Martin F. Stempien, Jr., assistant to the director, the researchers then will seek to determine the chemical composition of these substances and to investigate their potential as therapeutic agents.

Sponges have been known and used by man for thousands of years. It is only recently that the biochemical aspects of these animals have been investigated.

The Osborn Laboratories of Marine Sciences are equipped with piped-in sea water, and scientists there have conducted a systematic investigation of the extracts of an extensive collection of sponges from the Bahamas, Jamaica (West Indies), and the British Virgin Islands. The presence of anti-bacterial substances in extracts from 23 of the 125 Jamaican species studied seems to indicate that they are of rather common occurrence.

Under the new grant, the laboratories will attempt first to isolate from a variety of sponges sufficiently large quantities of the active substances which in pilot investigations have shown interesting possibilities as useful therapeutic agents. They will then seek to characterize chemically the active substances and to compare the physiological and pharmacological activity of the purified fractions with those of the newly derived compounds as therapeutic agents. Modern sophisticated techniques of purification and analysis – such as column, thin-layer, and gas chromatography – will be used.

This young red-tailed rat snake is one of six hatched at the Bronx Zoo in January. Hatching of this species in captivity is extremely rare. The red-tailed rat snake, a native of Southeast Asia, is a tree-dweller that preys on small mammals and birds. It reaches a length of about six feet. Quite colorful, it has a green body and red tail. The red-tailed rat snake, a non-venomous species, is a mimic of certain venomous snakes of its region.

BRONX DAY FESTIVAL SET FOR ZOO

A "People's Festival," featuring exhibits, music, pageants, and theatrical presentations will be held at the Bronx Zoo May 12 as part of a borough-wide celebration of Bronx Day, 1971.

Bronx Day, planned as a salute to the Bronx and its history, will also include a parade down the Grand Concourse, and a rock music concert, and a classical music concert. Scores of community organizations are participating in the celebration, which originated with Bronx Borough President Robert Abrams.

The festival at the zoo, which will begin at noon, will be highlighted by exhibits and presentations focusing on the many ethnic backgrounds of the citizens of the Bronx.

The zoo closing hour will be extended to 7:00 P.M. (Eastern Daylight Saving Time) for the festival. Exhibits will be constructed at various sites throughout the zoo. A number of participating groups – such as traveling players and dancers – will circulate throughout the festival areas.

Several foreign nations, as well as a number of corporations, have expressed interest in having representatives participate in the festival.

In announcing the details of Bronx Day, Mr. Abrams said, "It is my hope that Bronx Day will serve as a rallying point around which all Bronxites can join together in a common expression of brotherhood and pride in our borough. We must work together to make the Bronx a better place in which to live. Bronx Day can be the beginning of a renewed commitment on the part of all of us to improve the quality of life in our community."

The full cooperation of the New York Zoological Society in making Bronx Day a success was pledged by William G. Conway, general director of the society.

"As one of the great institutions of the Bronx," Mr. Conway said, "the Bronx Zoo is proud to participate in a salute to this borough, whose history originates before the founding of the United States as a nation."

DATES TO REMEMBER

April 18 - 24	Earth Week
May 12	Bronx Day

EDUCATIONAL SUMMER COURSES AT THE BRONX ZOO

During July the New York Zoological Society's education department will offer, for the first time, a family course at the Bronx Zoo for society members and their children of elementary school age. A second course for junior high school students will be given in August.

Topics will include proper pets and pet care, endangered and vanishing animals, and aquatic ecology, with a field trip to the New York Aquarium. For additional information and registration, contact the education department at the Bronx Zoo (telephone: 955-1500).

TOTEM POLE ADDED TO EXHIBIT AT BRONX ZOO

Spring visitors to the Bronx Zoo will find a colorful new addition next to the Big Bears Exhibit – an Alaskan totem pole. Known as the Chief Kyan totem pole, it was carved originally for the St. Louis World's Fair in 1904.

The totem pole has been erected in front of the exhibit area for Kodiak bears, also native to Alaska, and is not far from the willow-oak tree planted as a memorial to Dr. Fairfield Osborn, president of the New York Zoological Society from 1940 to 1968.

FROM A(RT) TO Z(OO) . . .

Joan Van Haasteren, Associate Editor of the New York Zoological Society, has been promoted to the position of Assistant Curator of Publications and Public Relations. After graduation from Manhattanville College in Purchase, New York, with a B.A. in art history, Miss Van Haasteren joined the staff of the Art Museum of Princeton University. From the museum, she went on to Princeton University Press, and prior to joining the society in 1968, she was associated with the Spiral Press in New York City.

Although the society has had several women on its staff during its 75-year history, Miss Van Haasteren is only the second woman to be promoted to assistant curator. Miss Grace Davall, Assistant Curator of Mammals and Birds since 1952, retired last October after 47 years with the society.

THE bookshelf

THE LIFE OF THE JUNGLE. *By Paul W. Richards. 232 pages. McGraw-Hill Book Company, New York, 1970. $4.95.*

This book, volume number 12 in the "Our Living World of Nature" series, describes the plant and animal, including human, life of the "jungle." The term "jungle," is frowned upon by some botanists, and even the author, a botanist himself, quickly explains that by "jungle" he means tropical rain forest. Then, in a section entitled "Different climates, different jungles," he discusses various other types of tropical forests – the seasonal forests of Vietnam, for instance.

As an easy-to-read survey of the ecology of the tropical forests, the book succeeds. Here is a book fit for enjoyable fireside reading, or for use as a secondary school textbook.

The author, professor of botany at the University College of North Wales, U.K., writes with somewhat more authority on the flora of the forest than the fauna. Some may question, for instance, the use of the term "crush" in describing the manner in which the anaconda dispatches its victims, or the use of the local term "alligator," where it is likely he means caiman. But Professor Richards makes the jungle come alive, from treetops to the forest floor. The book is well illustrated with photographs, mostly in color, and graphics. The graphics depicting life at different levels and times – stratification, nocturnal life, for example – are excellent.

An excellent special section, in sidebar fashion, is devoted to the Caribbean National Forest of Puerto Rico's Luquillo Mountains, the only tropical forest in the United States National Forest System.

The appendix contains a descriptive list of "Jungles and Junglelike Preserves of the World," and a fine section on jungle animals threatened with extinction.

Throughout the book, in an unemotional, effective style, the author makes a common-sense plea for preservation of at least some areas of tropical forest. In the face of human need for food and living space, he notes, large areas of the jungle are doomed to disappear. Certainly, he writes, there are undesirable aspects of the jungle – it

serves as a reservoir for diseases such as yellow fever. But Professor Richards is quick to point out that the trees and vines of the jungle produce many important plant products, including some of the drugs that are used to battle disease.

E.R.R.

SPIDERS AND THEIR KIN. *By Levi, Levi, and Zim. Illustrations by Strekalovsky. 160 pp. Golden Press, New York, 1968. $1.00.*

This handy guide to spiders and related arthropods is a much needed addition to the growing list of field guides. The arachnids are a very large group, and this guide, quite small and inexpensive, could not possibly cover all of them.

The authors wisely tried to cover just the families of spiders, showing a few representatives of each. The colored illustrations are good and the extra diagramatic drawings of certain parts are very helpful for identification purposes.

The one really outstanding feature of the book is its coverage of the less familiar orders which in the past have been almost completely neglected. The material given on such animals as the scorpion, the tick, and the centipedes is brief, but serves as a good introduction and general guide.

This book is written in a manner which should allow even the youngest enthusiast to make use of it, while at the same time it gives enough detail to make it of value to the biologist and the naturalist.

Don Bruning

comment

(Comment is a new feature of *Animal Kingdom*. It will feature editorial commentary on a wide variety of topics by members of the staff of the New York Zoological Society.)

Spring has arrived in this corner of our planet and with it the breeding calls of various frogs and toads swell from pond and marsh. In most places the hoarse clacking call of the wood frog has already sounded and its maker has mated and departed. On warm, moist nights the elfin piping of the spring peeper rises in chorus from almost everywhere in the countryside there is a bit of water. The musical trilling of the American toad floats on the air.

More silent are the salamanders, gathering to breed in quiet ponds during the dark of night. Creeping through the woodland litter they come to reproduce their species. These are creatures of the moist and hidden crannies, seldom seen during the remainder of the year.

Possibly even more than the robin that everyone looks for when the chill leaves the air, the amphibians are the heralds of winter's end. Though few frogs, toads, and salamanders are spectacular, at least according to the way that many people view the animal kingdom, they are to me among the most fascinating of all wild animals. And in common with even the most awesome of wild creatures, the secretive dwellers of the damp places are threatened because of loss of habitat.

The same pollution and destruction that endanger our largest rivers and lakes – and, of course, the sea itself – also doom the small wet corners that shelter the eggs of the spotted salamander and American toad. While the magnitude of a major oil spill attracts national or international concern, however, the desecration of a small patch of water often goes unchronicled. Yet even a temporary woodland puddle can be the source from which generations of amphibians can come. When such a source of life perishes, a little of the magic fades from the coming of spring.

Edward R. Ricciuti

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John L. Behler, Jr., is a zoologist in the Bronx Zoo's Department of Herpetology. **Charles Cordier** is a noted collector of wild animals who has provided a number of rarities for zoos of the world. **Walter R. Courtenay, Jr.**, is a biologist with Florida Atlantic University in Boca Raton, and **Vernon E. Ogilvie**, whose specialty is introduced species, is a biologist with the Florida Game and Fresh Water Fish Commission. **Frank Turkowski** is education director of the Phoenix (Arizona) Zoo.

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dying species...

"The beauty and genius of a work of art may be reconceived though its first material expression be destroyed; a vanished harmony may yet again inspire the composer; but when the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can be again."

William Beebe
First curator of birds, Bronx Zoo

THE OTTERS

This page has dealt, since its inception, with the term *species* in the singular. Unhappily the word is a plural one as well, and it can be applied to the otters as a group. The degree of endangerment varies, of course, and so does the source of the danger, but in the end if any species is lost, its death will be attributable to human greed. Here are a few cases in point.

The giant otter, *Pteronura brasiliensis,* largest of all the world's otters, is officially listed by the United States Department of the Interior as endangered. Commercial hunting appears to be the only reason for the sharp decline in numbers of this big mustelid, whose pelt brings as much as a jaguar's – often more than $50 a skin, and this to the low man on the furrier's ladder, the Indian in South America. With such a price on the otter's head it is not surprising that its populations should be depleted. In the two decades from 1946 onward giant otter skins exported from Peru fell from more than 2,000 to 200 yearly; the 90 percent decrease was due to no abrupt change in demand, but to a scarcity of otters. Less wary than its smaller cousins, the giant otter by all reports has not forsaken its diurnal way of life, so it remains a good target.

The marine otter, *Lutra felina,* is the smallest of the New World otters, and the strangest, in that it lives only in the coastal waters of the Humboldt Current, a salt-water environment. Comparatively little is known of its habits and it could become extinct before much more is learned about it. No more than 200 to 300 individuals are estimated to be left in Peruvian waters; the marine otter is reported to be very rare elsewhere within its range.

The La Plata otter *(Lutra platensis)* and southern river otter *(L. provocax)* may in fact be a single species, but their taxonomic relationship is becoming academic. Scientific expeditions have reported the species are virtually gone from much of their ranges.

English naturalists report an alarming decline in the numbers of their native otter, *Lutra lutra;* fur is not the issue there, but the "sport" of beating an otter to death after an arduous chase. The usual disposition of the carcass is to cut it up and throw it to the otter hounds to worry.

The Cameroon clawless otter, *Aonyx microdon,* is listed by the International Union for the Conservation of Nature as "very rare and believed to be decreasing in numbers." Like many smaller species accurate censusing is all but impossible; this specialized offshoot of the clawless otter could already be beyond help and we would be hard-put to prove it.

Where the lure of the fur market or the thrill of doling out death by the stroke have not endangered otters, other forms of human ambition have. The sea otter, *Enhydra lutris,* was once nearly wiped out throughout its range. A treaty signed at the eleventh hour saved it, and now a large population exists again in the Aleutians, and a smaller one, a thousand or so, in California waters. Neither the northern race nor the southern is considered to be endangered today, for their numbers are reasonably high. But underground nuclear blasts have been set off on the largest island home of the northern race. No report has been released to indicate that the blasts themselves killed any otters, but it will be a while before anyone can be sure that radiation seepage has not poisoned the otters' food.

The southern race is safe, presumably, from nuclear poisons, but is subjected to DDT, significant amounts of which have been found in sea lions from the area; moreover, a single, large-scale oil spill could cut the California sea otter population down to critical levels again.

JOSEPH A. DAVIS

Perhaps the most endangered otter of the group is the giant otter, ***Pteronura brasiliensis.***

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ABOUT THE COVER

Front: Nilgiri tahr *(Hemitragus hylocrius),* found on the high tableland of South India, have been depleted in number through habitat destruction and excessive hunting. For a field report on this endangered species, see "Cloud Goats" by Dr. George B. Schaller, on page 2.

Back: The blue honeycreeper *(Cyanerpes cyaneus)* is native to the tropical American woodlands. For more on this colorful bird and its family, see "The Honeycreepers of Tropical America" by Alexander F. Skutch, on page 7.

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A male Nilgiri tahr stands poised on a hillside in South India. Dark brown in color, with white throat and abdomen, the male has a silvery patch on the back, from which comes the local name of "saddle-back."

A tahr herd is composed of females and subadults, ranging from 5 to 50 animals in number. The herd composition is unstable, and the adult males are only temporary members of the group.

Cloud Goats

by George B. Schaller

A male Nilgiri tahr stood motionless at the edge of the escarpment, barely visible in the clouds that engulfed us. Huddled against the slope, I waited, chilled by a fog so thick that it felt like water against my face. All was silent except for the occasional whoop of a Nilgiri langur and the distant rush of water escaping these cool highlands in route to the hot coastal plain of Kerala in South India.

When the clouds parted, the male was still poised on the cliff, a strikingly handsome creature with stout 14-inch horns curving sharply backward and with a dark brown pelage, except for his white throat and abdomen. On his back was the silvery patch which has led local sportsmen to call the males "saddlebacks." He lacked the flowing mane on neck and shoulders characteristic of male Himalayan tahr. A slight movement drew my attention from the male and I saw other tahr, 33 females and subadults, resting among boulders and on patches of grass, their dusky brown pelage blending so well into their surroundings that I almost had overlooked them. Suddenly the wind shifted. Leaping to her feet, a female whistled shrilly, a piercing sound made by expelling air through the nostrils. The animals bunched and raced over the edge of the escarpment, fleeing along the ledges until their forms dissolved in the clouds.

I headed inland across the steeply rolling hills toward the small tent that was my camp, delighted to have found a piece of wild country with neither roads nor villages. Now, in October, shortly after the end of the southwest monsoon, the uplands were still green and covered with myriads of flowers – the pink spikes of twin-spur, the violet-like *Polygala,* and above all *Strobilanthes kunthianus,* which had turned the slopes a soft lavender. This low shrub blooms at irregular intervals every 7 years to 12 years and then dies.

Annual fires and grazing by domestic stock had denuded most of these hills before 1812, when the first Europeans arrived. Today only patches of stunted evergreen forest, the sholas, remain. Browsing timidly at one of these sholas was a sambar hind with a yearling and fawn at heel, a typical family association in this large deer. I detoured around a ridge so as not to disturb them. A little farther, on some scree, I found the dropping of an old tiger containing sambar hair and was pleased that this predator survived in the area. All the time, too, I scanned the slopes for tahr but found little sign of them away from the escarpment.

The Nilgiri tahr *(Hemitragus hylocrius)* is one of three widely separated species belonging to the genus *Hemitragus.* Confined to the hill ranges of

South India in the states of Tamil Nadu and Kerala, the tahr have become so depleted in number through habitat destruction and excessive hunting that they are listed in the Red Data Book of the world's threatened species. I spent one-and-a-half months in South India in 1969 to census tahr in several areas and to observe their behavior. The first few weeks of the project were devoted to the Nilgiris, a lofty tableland about 6,000 feet high. Although tahr once were widely distributed in these hills, they now survive only along the western border of the plateau. There, remoteness, the inclement weather – up to 300 inches of rain a year – and the interest of the Nilgiri Wild Life Association have combined to protect them.

Roaming along ridges and precipices, I searched for tahr, always hoping that the clouds, with which these goats seemed to have a secret pact, would not hide them. Tahr are social animals, with females and subadults living in herds of about 5 to 50 animals, although one herd I saw in the High Range numbered 104 individuals. Herd composition is not stable as individuals and groups break away and rejoin in various combinations. However, the animals tend to remain for weeks in a limited area and often I found the same ones on the same cliff on successive days. As is the case with other hoofed animals, the adult males are only temporary members of herds. They join the herd and part with it on their own volition.

Judging by the size of young which are born between December and February after a gestation period of about six months, the rut of the Nilgiri tahr is probably between June and August. At that time most males are likely to be around the females. After the rut is over, adult males spend progressively less time with herds, until by late October only about 20 percent of the males I saw were with them. The others live singly and in all-male groups, numbering as many as 12 individuals, and they sometimes wander far from the cliffs around which a tahr's life usually revolves.

Tahr are exceedingly restless animals. They lie, graze, move, and look around at frequent and irregular intervals, which makes it difficult for an observer, or a predator, to approach undetected, especially since the animals often stay near hilltops and other vantage points. Tahr have excellent eyesight, yet they seem to trust their sense of smell more when deciding about the potential danger of an ambiguous situation. One day, as I reclined on a slope watching a distant herd, 15 tahr filed over a rise only 60 feet from me. When they spotted me, they whistled and stamped their feet, but soon they merely looked and finally some lay down chewing their cud. But 30 minutes later when the wind shifted, all bolted.

By classifying each individual into age and sex classes, I obtained some idea of the dynamics of the tahr population. About 21 percent of the 176 ani-

mals that I saw in the Nilgiris consisted of males two or more years old and of these 9 percent were saddlebacks; females comprised 34 percent, yearlings 19 percent, and young 26 percent. Reproduction and survival of young was obviously good: three-quarters of the adult females were accompanied by a large young. However, over a quarter of these young would die in the coming 12 months, judging by the percent of yearlings in the population and assuming that reproductive and survival rates of young are similar each year.

I have little precise information about causes of death in tahr. The Indian wild dog, brick-red except for its striking black tail, is said to kill them, and jackals possibly take some fawns. Both tiger and leopard occur in the area, but all these predators are now so rare that their effect on the tahr is negligible. Disease, introduced by domestic stock, and poaching are probably the most important mortality factors. After censusing several areas, and extrapolating for those parts I did not visit, I derived an estimate of 300 tahr. E. R. C. Davidar of the Nilgiri Wild Life Association had conducted a census in 1963 and derived a similar figure, suggesting that this rare goat is holding its own in the Nilgiris.

About 60 miles south of the Nilgiris lies the High Range, an area of deeply dissected valleys and towering crags which is "surpassingly grand and incomparably beautiful," in the words of D. Hamilton, who was one of the first visitors to the area in 1854. Tea plantations cover the valleys and slopes, but the high, grassy plateaus, where frost settles in the boggy hollows, remain free of human disturbance.

The Eravikolam Reserve lies on one of these plateaus, an area of about 30 square miles of rolling hills surrounded by precipices on three sides. It is

Tahr are restless animals, ever-alert, and often remain near their hilltop vantage points. They have excellent eyesight, and observations have shown they also rely on their sense of smell to avoid danger.

protected by the High Range Game Preservation Association, and the largest Nilgiri tahr population in the world survives there. My census indicates that it consists of about 500 animals. Through the kindness of Mr. J. C. Gouldsbury, I was able to spend three weeks in this private reserve where I studied particularly the aggressive behavior of the tahr.

Tahr are considered to be goats though they lack a beard and the long scimitar-shaped or spiralling horns characteristic of the genus *Capra.* But they certainly smell like goats. Paleontologists suggest that the caprids evolved from rupicaprids, of which the American mountain goat and chamois are examples. In many ways the physical characters of tahr are intermediate between the two groups, and I was interested to find out in what ways the aggressive behavior of tahr resembled the true goats on the one hand and that of the rupicaprids on the other.

When two tahr were fighting, they usually lowered their heads and lunged at each other from a distance of two to three feet, their horns meeting with a crash. Such horn bashing is also common in various sheep. Occasionally two tahr stood side by side, facing in opposite directions, and circled rapidly, all the while jabbing at each other's flank and abdomen. Only males were seen to behave in this fashion. A similar method of fighting was described for mountain goats by Dr. V. Geist of the University of Calgary. Tahr also rear bolt upright on their hindlegs with chin tucked in, and, plunging downward, crack their horns together. This is a characteristic method of fighting among ibex, markhor, and other members of the genus *Capra.*

A conspicuous posture, which I termed the "hunch," was sometimes shown in an aggressive situation. Hunching its back and arching its neck so far down that its muzzle almost touched the ground,

High in the hills of South India, author George B. Schaller observed the behavior of the Nilgiri tahr. Dr. Schaller also conducted a census of these vanishing animals in several areas.

The Indian sambar is a large member of the deer family found in tahr country. The male has shoulder height of 48 to 56 inches and a weight of 700 pounds.

the animal moved with a stiff gait, legs bunched beneath its body, broadside past its opponent. This posture makes the animal look formidable and probably serves as an intimidation display. Interestingly, mountain goats use an almost identical posture.

Thus the aggressive patterns of the Nilgiri tahr reflect their ancestry: their method of butting is common among horned animals in general; their hooking into the posterior part of an opponent, as well as the hunch display, point to a rupicaprid relationship; and their distinct way of rearing up is a typical caprid trait.

Although populations of tahr survive in several localities, according to J. C. Daniel of the Bombay Natural History Society, only those in the Nilgiris and the Erivakolam Reserve are large and fairly well protected. A few male tahr are still shot on license in these two areas, but such regulated hunting is not detrimental to the species. In fact, tahr survive there only because local sportsmen have protected them. In areas where such private interest and initiative have been lacking, tahr have been decimented or extirpated. Now a new threat hovers over the Eravikolam Reserve, where perhaps one-third of the world's tahr population survives. The Kerala Land Reforms Act of 1963 permits the state to take over all privately-owned land that is uncultivated. Fortunately the owner of the reserve, the Kana Devan Hills Produce Company, is discussing the possibility of presenting the area to the Indian nation in the form of a trust with various national and international conservation organizations acting as trustees. This will help insure that this lovely corner of India, high above the green valleys, will remain a haven for the tahr, the great goat of the clouds.

The Honeycreepers of Tropical America

by Alexander F. Skutch

Among the daintiest and most colorful of the birds that flit through tropical American woodlands are the honeycreepers. The 36 species of this exclusively New World family fall naturally into three divisions.* The largest consists of the typical honeycreepers or dacnids — delicate, gem-like birds with slender bills and glossy plumage. The males are blue of various lovely shades, or less often, bright green, with black. Trimmings of yellow, red, or white add to their brilliant color. The second division contains the flower-piercers, distinguished by a bill highly-modified for extracting nectar from flowers. The males are usually deep blue, slaty, or blackish. The third division consists of a single species, the bananaquit *(Coereba flaveola)*, which has given its scientific name to the family as a whole. This is unfortunate,

The most abundant honeycreeper is the bananaquit, marked with a broad white stripe above each eye on the blackish head, and a sharp, down-curved bill.

**(Editor's Note: Many taxonomists do not recognize the honeycreepers as a family group, relegating several genera to the wood warblers and the rest to the vireos.)*

for it is in many ways the least typical of its members and appears to be derived from the wood warblers, whereas most other species of the Coerebidae seem to be more closely related to the tanagers. The sexes of the bananaquit are alike in plumage; but in most other honeycreepers, the male is more richly colored, often contrasting strikingly with the female.

The most widespread of the honeycreepers, the bananaquit ranges from northern Argentina to southern Mexico. It has also colonized the Bahamas, most of the West Indies, and many other islands in the Caribbean Sea as well as off the Pacific coast of the Americas. Most of the rest of the family is largely confined to the tropical mainland; but the blue honeycreeper *(Cyanerpes cyaneus)* has reached Cuba, where it may have been introduced by man. It is the only member of the family on that island, from which the bananaquit, so widespread in the Antilles, is absent. Another honeycreeper, the orangequit *(Euneornis campestris)* is found only on the island of Jamaica. The typical honeycreepers and the bananaquit are heat-loving birds rarely found more than 5,000 feet above sea level. The flower-piercers prefer the cool highlands.

The most familiar of the typical honeycreepers is the blue, or red-legged, honeycreeper (also known as the yellow-winged sugarbird). The male's plumage is deep blue, with clear turquoise on the crown, and black on his lores, back, tail, and wings. When spread, the wings reveal the otherwise hidden yellow of their undersides. The female is greenish-olive, with faint streaks on her breast. A curious fact about these birds is that, as the breeding season ends, the male molts into an eclipse plumage not greatly different from that of the female. I have watched male blue honeycreepers gradually go into eclipse while still feeding nestlings. In southern Costa Rica, they wear their dull plumage for only a few months, from June or early July until September or October.

Annual changes in coloration, so familiar in northern birds, are rare in those constantly resident in the humid tropics. As far as I know, the only other songbird in tropical America that goes into eclipse is the male blue-black grassquit *(Volantinia jacarina),* which after the nesting season exchanges its shining nuptial attire for the brownish garb like that of the female.

Captivity is the price that blue honeycreepers too frequently pay for their loveliness. They die in large numbers in captivity; but when properly attended they have lived for 24 years, a surprising age for so small a bird.

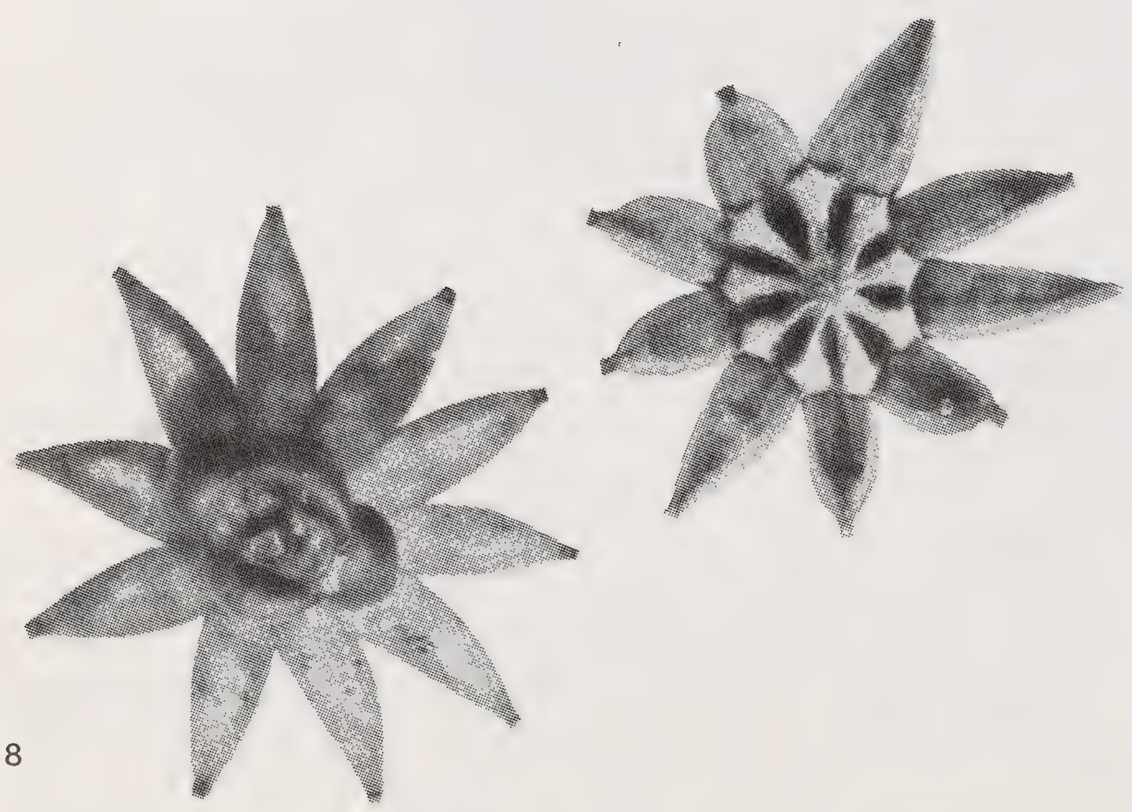
Blue honeycreepers roam through the treetops in loose flocks of both sexes. Sometimes they swarm in the shade trees of Central American coffee plantations, especially when the Inga trees display masses of white, powder-puff flowers on their open crowns. With long, slightly curved, black bills, the honeycreepers probe these and other blossoms, usually while clinging to them. Nectar, however, is a minor item in their varied diet. They also glean small insects from foliage and the finer branches.

Blue honeycreepers are among the five kinds of honeycreepers that visit the feeding table at our Costa Rican home for bananas and the juice of halved oranges. The others are the shining honeycreepers *(Cyanerpes lucidus),* the green honeycreeper *(Chlorophanes spiza),* the turquoise dacnis *(Dacnis cayana),* and the bananaquit.

The favorite food of all these honeycreepers, except the bananaquit, is the soft coat, known as the aril, that encloses each hard little seed of *Clusia.* This is a large genus of trees and shrubs that grow chiefly as epiphytes upon bigger trees in tropical America. Their white or pinkish and often very fragrant flowers are followed by roundish fruits. When ripe the fruits open by spreading pointed valves, until they resemble stars with four to a dozen rays, according to the species. Each ray bears a mass of tightly packed, bright red seeds. Although tasteless or bitter to me, they are evidently delicious to the honeycreepers.

For a number of years, a tree of *Clusia rosea* grew on a calabash tree close by our feeding shelf. Neglecting the bananas, the blue, shining, and green

When opened, the ripe fruit of the *Clusia* resembles a star or pinwheel. It is the favorite food of most honeycreepers.



A bird of many names is the blue, or red-legged honeycreeper, which also is known as the yellow-winged sugarbird. It is the most familiar of the typical honeycreeper group.

The female green honeycreeper builds a shallow nest of dead leaves and fine petioles, held together with cobweb and vegetable horsehair.

honeycreepers flitted around the apple-sized green fruits waiting for the valves to separate. In this same tree, a pair of golden-naped woodpeckers *(Tripsurus chrysauchen)* were feeding their well-grown young with the seeds, which their stronger bills could extract from barely-open pods, still inaccessible to the honeycreepers. Repeatedly I saw a blue honeycreeper try to intercept some of this coveted food that the male woodpecker was passing to his offspring, but apparently the would-be thief never was successful.

Blue honeycreepers are pacific birds. To be sure, like most creatures they sometimes disagree among themselves; but their disputes always are settled by displaying to each other rather than coming to grips. The contestants are invariably two individuals of the same sex, either male or female. Facing each other, the rivals repeat incessantly their nasal *chaa,* while they bow, pivot from side to side, and flit their wings. Male opponents flash the bright yellow of the wing-underside in each other's face. These long-drawn-out disputes are contests of endurance. If one has the patience to watch to the end, he may notice that, after a while, the calls and movements of one of the contestants come less frequently than those of its opponent. Finally, the bird that seems to tire flies away, sometimes pursued by the other.

The male green honeycreeper has the habit of suddenly, without any obvious reason, seizing some other small bird by its tail, or less often by a wing or a leg, and holding on tightly until the protesting victim manages to pull away. Usually the bird seized is a female green honeycreeper; but I have seen a male green honeycreeper treat a blue honeycreeper and a small tanager in this same fashion. If not simply a manifestation of bad temper, these seizures may be sexually motivated, but I have seen this behavior in no other bird.

A black, hanging basket formerly was thought to be the nest of the blue honeycreeper. Now, however, there is abundant evidence from Mexico, Central America, and Brazil that this species builds a small open cup amid concealing foliage, as is true of all the dacnids, as far as we know.

After searching for many years, I recently found a nest of the shining honeycreeper. It was built in a drooping spray of a tall timber bamboo in front of my study window. Constructed of fine, dark fibers, the fabric was so open that I could count the eggs through the bottom, which was fortunate, as the nest was inaccessible. A nest of the scarlet-thighed dacnis *(Dacnis venusta)* which I found was even slighter: a shallow hammock composed of rather coarse, wiry materials 50 feet above the ground. The bottom was well covered with living fragments of a fern, which blended so well with the dense foliage around the nest that I was long in finding it, even after I had climbed into the tree where I had seen the parent birds carrying food.

The nest of the turquoise dacnis is deep and soft, composed of fine bast fibers and similar materials bound together and attached to the supporting twig with cobweb. The shallow nest of the green honeycreeper is made largely of dead leaves and fine petioles, held together by cobweb and the dark fungal strands known as vegetable horsehair.

In these species, I have seen only the female build the nest, with materials plucked from trees and the epiphytes rather than gathered from the ground. The female alone incubates the two, or rarely three, white, spotted eggs. At intervals the male turquoise dacnis brings food to his sitting partner, but I have not seen other honeycreepers do so.

The eggs hatch after an incubation period of 12 or 13 days. The male then helps to feed the nestlings. I watched a nestling turquoise dacnis fed by two males in full nuptial plumage. Most of the time they seemed to get along, although occasionally one chased the other. The second male was evidently an unmated helper rather than a member of a polyandrous trio. Typical honeycreepers do not regurgitate food for their young but carry it in the bill, mouth,

or throat. Food consists of small insects, berries, and great quantities of the red arillate seeds of *Clusia,* which sometimes are lined up along the whole length of the slender bill, adding another touch of color to the birds. The young remain in the nest for 13 or 14 days.

The male blue honeycreeper brings food to the nestlings less often than the female, but after the young leave the nest, the male may be their chief attendant. Occasionally, he responds to the begging of some fledgling of another species. One male honeycreeper I observed fed a juvenile yellow-green vireo *(Vireo flavoviridis).* Another time, I watched a blue honeycreeper attend a young scarlet-rumped black tanager *(Ramphocelus passerinii)* twice his own size. The noisy youngster frequently came to the feeding table with its silent attendant, and with fluttering wings took banana from the honeycreeper's sharp bill. The tanager also followed its foster parent through the trees, receiving insects and berries. Although it could feed itself and its own father still attended it, the young tanager seemed to prefer the gifts of the obliging honeycreeper.

The flower-piercers of the genus *Diglossa* differ greatly in appearance and behavior from the typical honeycreepers. Most abundant in the tropical Andes, they range from the bleak *paramos* above timberline down to the upper levels of the Tropical Zone at about 3,000 feet. One species inhabits the mountains of Costa Rica and western Panama, another the highlands of northern Central America and tropical Mexico.

The flower-piercer's short, uptilted bill has an abruptly downturned hook at the end of the upper mandible, while the shorter lower mandible is awl-like. This peculiar bill is an efficient instrument for extracting nectar from flowers with tubular corollas. The upper mandible hooks over the tube and holds it steady while the sharp lower mandible pierces the tissue. Apparently the fringed tongue enters through the perforation to extract the sweet fluid. The flower-piercer can perform this operation rapidly, and can remove the nectar from several flowers in the course of a minute.

From the point of view of the flowers, these little birds are inveterate thieves, never transferring a grain of pollen to pay for their meals. If the glittering highland hummingbirds, the bees, and the butterflies did not carry the fertilizing grains from flower to flower, the diglossas might go hungry, because the plants on which they depend for nourishment would fail to be pollinated and would not perpetuate their kind.

Like hummingbirds, flower-piercers supplement their sugary diet with proteins derived from the many small insects that they catch in the air. Although their bills seem no better adapted for this mode of foraging than those of hummingbirds, they are at least equipped with bristles at the corners of their mouths, in the manner of flycatchers. These bristles evidently help to deflect insects into the gape. Sometimes flower-piercers press the juice from small berries, then drop them to the ground.

Flower-piercers demonstrate convincingly how the nesting seasons of birds are controlled by their food supply. In the western highlands of Guatemala, where the dry season is long and severe, practically all of the small birds begin to nest as the dry season approaches its end in April or early May. Breeding continues into June or July, when cold rains are frequent. The hummingbirds, however, chiefly nest early in the dry season, from November to January, when bright sunshine covers the high mountains with colorful blossoms, although nights are frosty and penetratingly cold.

Parting company with all the passerines to which it is most closely related, however, the cinnamon-bellied flower-piercer *(Diglossa baritula)* joins the unrelated hummingbirds to breed in the frosty, flowery months at the year's end. Amid low shrubbery, the female builds an open cup much thicker and more substantial than the nest of a typical honeycreeper, as is necessary on these chill heights.

The male green honeycreeper often seizes the female, or a small member of another species, by its tail, a form of behavior the author has seen in no other bird.

She lays two bright blue eggs, heavily spotted with brown on the thicker end, which she alone incubates. Both parents feed the nestlings, with nourishment regurgitated from inside, in the manner of hummingbirds, rather than carried in the bill and throat, as in the typical honeycreepers. The flower-piercers sing more freely than the dacnids, but no member of the family known to me is a fine songster.

The tiny bananaquit, with its blackish head adorned by a broad white stripe above each eye, dark upper plumage, and bright yellow underparts, shows no family resemblance to the other honeycreepers. Bananaquits on the Lesser Antillean islands of St. Vincent and Grenada are melanistic, with almost uniformly black plumage. In all races, the short, sharp bill is downcurved. A nectar-feeder like the flower-piercers, it tirelessly probes flowers of many kinds. If the corolla is too deep for its bill, the bananaquit perforates the base, accomplishing this with a bill less highly modified than that of the flower-piercer. The bananaquit also gleans small insects and spiders from foliage and twigs.

Despite its name, the bananaquit is not nearly so fond of bananas as are the typical honeycreepers. On its infrequent visits to our table, it seems to sip moisture from the surface of the fruit rather than to eat solid bits, as all the other bird guests do. The bananaquit punctures juicy berries, such as those of the pokeweed that springs up in recently-burned clearings, and sucks out the juice. On some of the West Indian islands, bananaquits enter houses to search for spiders, or take sugar or syrup from the dining table. On the mainland, they are less familiar with man.

Through much of the year, bananaquits sing tirelessly, in thin, high-pitched voices of no great charm. Of all the birds I know, they are the most assiduous nest-makers, seeming to spend almost half their lives building cozy globular structures with a little round doorway at one side of the bottom. These roofed nests, so different from the open cups of other honeycreepers, are placed in a tree or shrub, and composed of almost anything suitable that the locality affords: coarse vegetable fibers, grass blades, strips from banana leaves, weed stems, rootlets of epiphytic plants, tendrils, green moss, and the like. The nests are built at all seasons. Most of them never contain eggs but are used only as dormitories.

Often in the night, the flashlight's beam that I have thrown upon a bananaquit's nest has revealed a soft yellow breast blocking the doorway, or else the boldly white-striped, black head of the awakened bird, gazing down at me with shiny black eyes. The dormitory nests are always occupied by a single bird, which will not even permit its mate to join it.

In the season when many kinds of birds breed, bananaquit dormitories, unguarded by day, are often torn apart by other birds gathering materials for their own nests. Finding itself roofless at nightfall, the bananaquit may use the uncovered nest of some other small bird. Once I watched one try to enter the mossy globe in which a paltry tyranniscus *(Tyranniscus vilissimus)* was raising a family, but the intruder was spiritedly repelled by the pair of tiny flycatchers. Turning the tables, sometimes a wren lodges in a bananaquit's nest, as do small mammals such as the marmosa or pygmy opossum.

Unlike typical honeycreepers, bananaquits never flock. Also unlike the dacnids of the same region, they breed almost throughout the year. In the Valley of El General in Costa Rica, where I have studied them, their eggs have been found in every month except April. Yet in April and May, at the beginning of the long rainy season, when fruits and insects are plentiful but flowers relatively scarce, the nesting season of the great majority of the birds is at its height. From December to February, at the beginning of the dry season when flowers are abundant but hardly any songbirds have nests, Bananaquits—and some hummingbirds—breed freely.

The male helps his mate to build the nest in which she sleeps before she lays her eggs, but I have never known the female to help build the male's dormitory. The two or three eggs, whitish with brown spots, are incubated for 12 or 13 days by the female alone. The male joins in feeding the nestlings, by regurgitation, as is usual in nectar-drinkers.

If undisturbed, the young remain in their well-enclosed nursery for 17 to 19 days, which is considerably longer than other honeycreeper young stay in their open nests.

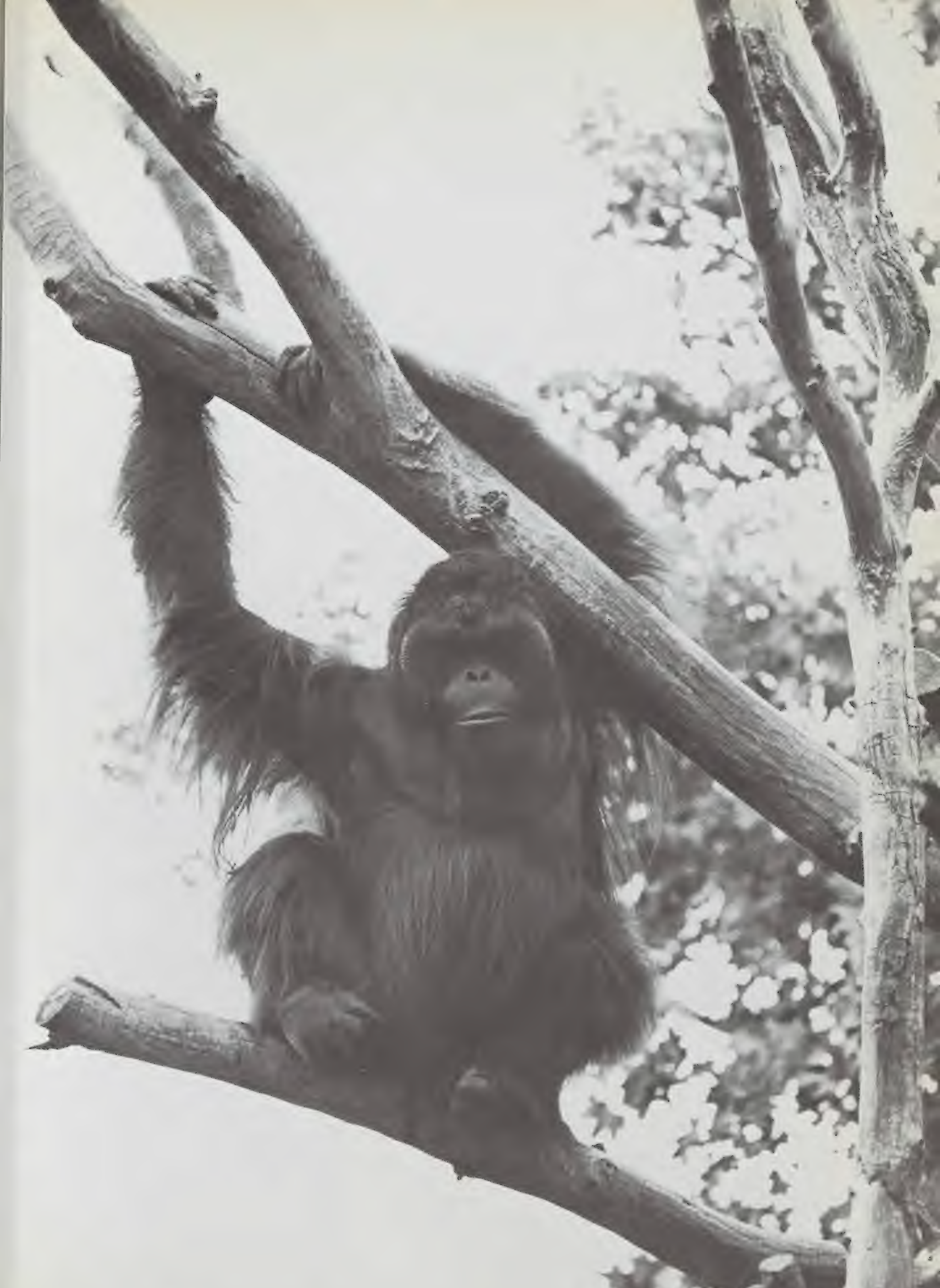
Although the female may continue to sleep in the nest from which the young have flown, she does not lead them back to its shelter. They must find such lodgings as they can, until, while still in the dull juvenal plumage, they undertake to build their own dormitories. Even then, the adult in whose territory a youngster has built may evict it from the newly-made nest, causing it to start another. Thus, at an early age, it begins its life-long occupation of nest-building.

ORANG-UTAN

Photographs by Bill Meng

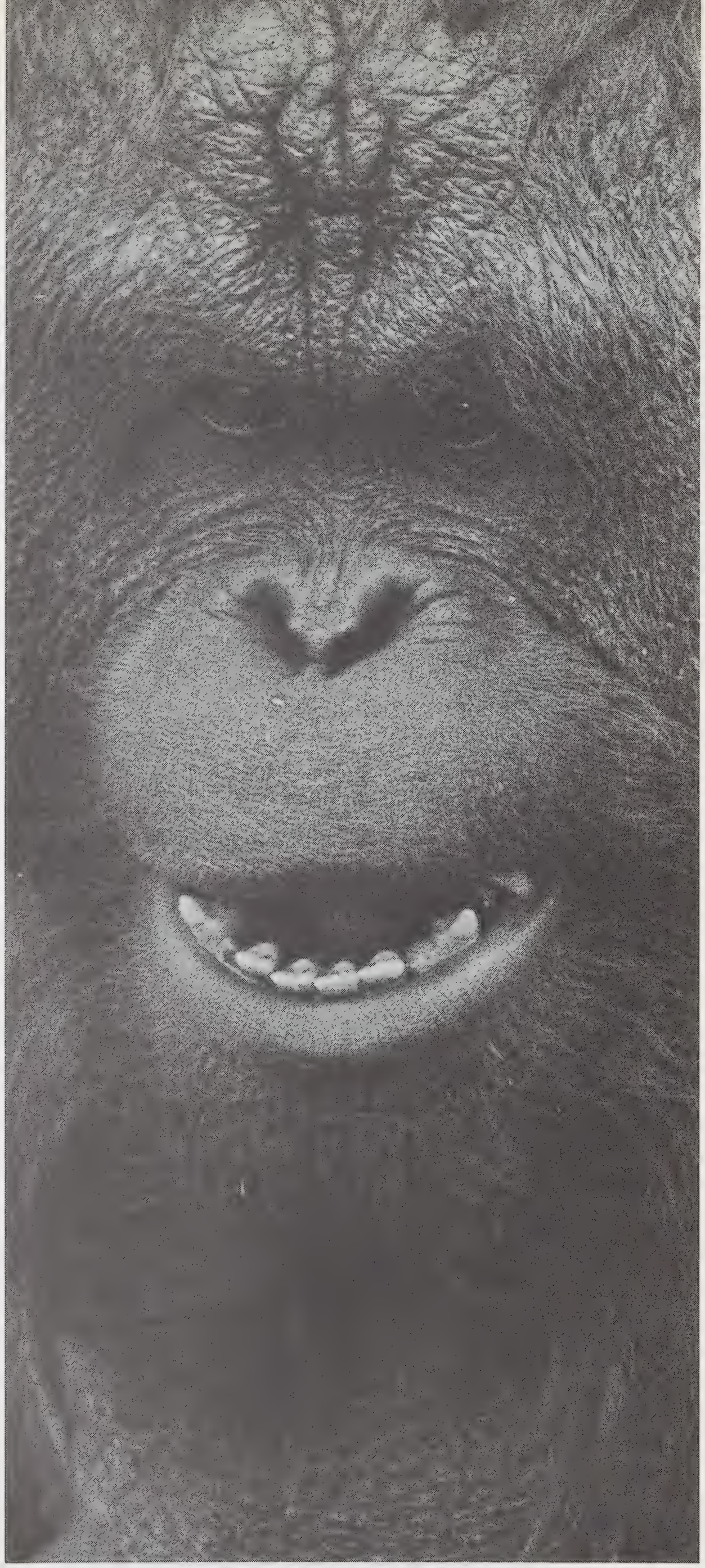
The name orang-utan means "man of the woods," and this great ape lives in the forests of Borneo and Sumatra. Its days in its natural habitat may be numbered, however, as destruction of forests, spreading agriculture, and hunting annually decrease its numbers.

The orang is the only great ape with bright reddish hair. The adult males develop a characteristic facial disk, sometimes a foot or more in diameter.



With his long manipulative fingers, Ollie, an adult male orang at the Bronx Zoo (shown in all the photographs), appears to be playing a twig as if it were a flute.

Adults of both sexes develop a large pouch on the throat and chest. The pouch may have a function in producing the male's terrifying roar.



The hand of an orang, with the exception of its shortened thumb, is amazingly human-like in appearance.

The Fruit Fly

A MOST IMPROBABLE HERO

by Edward Edelson

As is true with humans, so it is with animals: some are born great, some achieve greatness, and some have greatness thrust upon them. The lordly lion and the magnificent whale need only to exist to be recognized as great. The duck-billed platypus and the cockroach, not otherwise notable for beauty or strength, achieve greatness because of the stubborness and success of their fight for survival against long odds. And finally, near the top of the list of those which have had greatness thrust upon them, comes the most improbable hero of all – the fruit fly.

Less than half the size of the famous house fly and with a name that implies only minor virtues and vices *(Drosophila melanogaster*–"the black-bellied dew-lover"), the fruit fly still has managed to participate in a good share of the pivotal biological discoveries of our century. Its participation is admittedly minimal; all it has to do is live, breed, mutate, and follow the laws of heredity. Nevertheless, the fruit fly's part in those discoveries has been as important as the genius of the scientists who study it. By analyzing what happens as the fruit fly multiplies, those scientists have been able to get major insights into the laws that govern the rules of heredity.

Consider, for example, one of the most unlikely great moments in the history of science: the settling of a fruit fly on a laboratory bench at Columbia University in 1910.

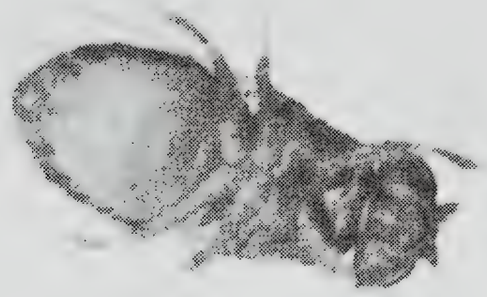
The scientist in charge of the laboratory, Thomas Hunt Morgan, was conducting research on the frontier of biology – the laws of heredity, outlined by Gregor Mendel more than 30 years earlier, forgotten and ignored, and newly rediscovered. Morgan had been trying with little success for months to induce mutants in his laboratory colony of *Drosophila melanogaster.* His failure was a roadblock in the effort to confirm and extend Mendel's findings.

It was Mrs. Morgan, a biologist employed in the laboratory, who first noticed the fly on the laboratory bench. What her trained eyes noticed mostly was the color of the fly's eyes. The normal flies in Morgan's collection all had red eyes. This one had white eyes. Nature had put into Morgan's hands the mutant fly he needed for his work. (Actually, Mrs. Morgan, who led the chase that ended with capture of the white-eyed fly, gets the final credit.)

Mating the mutant fly with a normal *Drosophila,* Morgan found something Mendel had not. The white-eyed mutant was a male, and only male offspring had white eyes. According to Mendel's laws, genes governing characteristics, including eye color, were parceled out evenly among all descendants. But Mendel had worked with peas, not animals. As Morgan studied his own results, he realized that Mendel was basically right, but that an important emendation to that law of heredity had to be made. Genes were parceled out evenly, all right, but the genes were grouped together to form chromosomes. Apparently, the gene for eye color and the gene for sex were linked on the same chromosome. Other characteristics were linked in the same way. Long study of tens of thousands of fruit flies enabled Morgan to confirm that gene linkage is a basic principle of genetics.

Morgan won the Nobel Prize for his work – the first of at least three Nobel Prizes in which *Drosophila* is directly involved. Actually, he was not the first to realize the value of *Drosophila* for genetic research. Credit generally is given to Clyde Melvyn Wentworth, professor of entomology at the University of California, for first demonstrating the usefulness of the fruit fly in research. Many other scien-

Fruit flies, less than half the size of the common house fly, have contributed a giant's share to scientific knowledge in this century.



tists soon followed the lead. Today, every biology textbook or popularization includes at least a mention of *Drosophila,* and several weighty books have been devoted entirely to the fruit fly, detailing its physiology, anatomy, and histology voluminously for the benefit of specialists.

As far as these specialists are concerned, only a few of *Drosophila's* characteristics are of interest – those characteristics that make it useful in the laboratory. The fruit fly is easy to catch: simply set out a rotting banana and a swarm will gather. It is also easy to raise. A bottle and some overripe fruit are often equipment enough for a *Drosophila* colony. It breeds quickly, producing a new generation in 10 to 12 days. And it can be raised by the thousands starting with just a few individuals.

Only entomologists are interested in the other characteristics of the fruit fly, and their interest cannot really be described as overwhelming. In most respects, a *Drosophila* outside the laboratory is just another member of the insect crowd.

Among insects, the fruit fly belongs to the order Diptera, or two-winged flies. Within that order, it is a member of the suborder Cyclorrhapha. The members of this suborder are distinguished by their small size and mouth-parts, which are adapted for sucking up exposed fluids, rather than for biting and piercing.

This large and miscellaneous suborder includes the vast majority of all flies; another member is the family of house flies. *Drosophila* gets its name from its penchant for anything fruity and fermenting, even alcoholic beverages. Says entomologist Harold Oldroyd of the British Museum: "Sometimes when you are sitting over a glass of wine, you will see a little tiny fly hovering clumsily and tantalizingly before your eyes. Don't dismiss it as one of the elusive *muscae volitantes* or a djinn out of the bottle; it is probably *Drosophila melanogaster* or the less welcome *D. repleta."*

Drosophila repleta is less welcome because of some of its uglier habits, which can include breeding in hospital bedpans. *D. melanogaster* and most of its other relatives, on the other hand, are cleaner types. They lay their eggs – up to 3,000 of them for a single female under the right circumstances – in decaying fruit, fermenting sap, and similar material. The larvae feed on microorganisms within the fermenting mass. *Drosophila* usually is not connected with any particular disease, and it is not listed as an enemy of man, despite the fact that it is found in a variety of places feeding on a number of different

types of fruit and sap. Had they not been chosen as an object of research, the various species of *Drosophila* would be living their lives in relative obscurity, noted only by entomologists and then mostly in passing.

Considering all this, some of the things that man has done to *Drosophila* in the name of science can be described by insect-lovers as unfair. For example, Hermann J. Muller deliverately exposed *Drosophila* to x-rays to induce mutations – a series of exciting experiements that produced crucial new information about genes and mutations and won Muller a well-deserved Nobel Prize. Specialized textbooks today list page after page of drawings of the abnormal formations that can be produced by irradiating fruit flies or using other methods of inducing mutations.

Students of human nature and the animal world may reflect on the fact that similar pictures of dogs or cats would produce cries of shock and outrage among animal lovers. Yet not a voice is raised to protest this treatment of the fruit fly, despite its harmless nature and faithful service. For the cynic, this is just another indication that position (especially on the evolutionary ladder) is as important in the animal world as it is in human society.

Of course, *Drosophila* has brought this treatment

on itself by its physical features. One of the most remarkable of those features was unsuspected at the turn of the century, when research with *Drosophila* began. Yet over the years, this feature has made the fruit fly almost irreplaceable for genetic studies.

In most cells, the chromosomes are visible at best as wavy, indefinite lines, even under the best microscopic magnification. As for the genes, they are only unguessable locations on those lines.

But in the salivary glands of the larvae of *Drosophila,* that's not true. For some reason, the chromosome in these salivary cells behave in a most unusual fashion. They divide over and over, and the daughter strands of the chromosomes remain juxtaposed, becoming enfolded to form thick, easily visible structures that are a full millimeter – about one twenty-fifth of an inch – long. These cable-like giant chromosomes are 100 to 200 times bigger than normal chromosomes. And on these chromosomes can be seen bands of varying length and color. These bands have been identified with individual genes. So geneticists have not only been able to measure the length of a single gene (about 1,250 angstroms, or one-hundred-millionth of a centimeter) but have also been able to map the location on the chromosome

of genes that are responsible for individual characteristics. Considering the fact that many scientists doubted the existence of genes when research started, the contribution of *Drosophila's* peculiar giant genes to science are obviously great.

With all these accomplishments in the past, what does the future hold for *Drosophila*? In the laboratory, the future is clear – more of the same. While other organisms have come along to share the attention of geneticists, the fruit fly still is raised in countless millions in dozens of laboratories. In fact, as scientists look closer, they can find other reasons for studying *Drosophila.*

Its breeding habits, for instance. Watching fruit flies breed in laboratory bottles, students of insect behavior have noticed that the ritualized process of mating depends mostly on odor and touch.

The male fruit fly starts the courtship by tapping the female with his front legs, apparently using the sense organs on the tips of the legs to ensure that the other fly is indeed a female. As the courtship continues, the female decides, apparently by odor, whether or not her suitor belongs to her own species. If he doesn't, the courtship ends abruptly – a fascinating method of preserving the identity of the species even when several closely related types of fruit flies may live close together. Herman T. Spieth, who studied the mating behavior of 101 different species of fruit flies at the City College of New York several years ago, found that while closely related species have similar postures for mating, differences in sexual odors prevented interbreeding.

So the survival of *Drosophila* in the laboratory for one type of study or another appears secure. After all, the fruit fly offers one feature that scientists, like most other humans, find irresistible: cheap labor. But how about *Drosophila* in the wild?

Here the future seems equally secure. The fruit flies belong to the order of flies which have the greatest evolutionary vitality. New species are believed to be evolving continuously, as *Drosophila* spreads into new evolutionary niches. *D. melanogaster's* family tree, already large, seems to be increasing steadily. There may be a lesson here for humans. Since fruit flies revel in fermenting things, they can be regarded as being the souses of the insect world, and yet their taste for *spiritus frumenti* seems to do them good, not harm (perhaps because they have no livers). The unsung, bibulous hero of the laboratory is also making good in the outside world. Says entomologist Oldroyd:

"There is a certain irony in the fact that, while the laboratory geneticist is showing his powers over nature by molding his fruit flies as he pleases, the flies themselves are staging a quiet demonstration of their own."

The pike killifish, *Belonesox belizanus,* a native of southern Mexico, Yucatan, Guatemala, and Honduras, is a recent introduction into the freshwaters of southern Florida. The introduction of this fish, a fierce predator, is the consequence of the home aquarium trade, and since the early 1960s, it has become well established in the Miami area. *Belonesox* is a member of the family Poeciliidae, livebearers, to which belong such well known and decorative aquarium fishes as guppies, mollies, swordtails, and platyfish. What sets *Belonesox* apart from all other members of the group is its large size, fierce looks, and predacious habit.

Belonesox, which grows to a length of eight

I have encountered *Belonesox* everywhere in British Honduras. It is especially abundant around Belize (the species was described in 1860 from specimens collected near Belize, hence *belizanus*). Up to two dozen adult *Belonesox* can be seen at any one time in the channels and ditches through the mangrove forest there. But even inland, in such seemingly unpromising places as small temporary pools in an otherwise dry palm-pine savannah, *Belonesox* is found, always surrounded by swarms of gambusias (mosquitofish), platyfish *(Xiphophorus maculatus),* or both. These smaller fish form the mainstay of the pike killifish's diet.

A stock of *Belonesox* is maintained at the Osborn

The Pike Killifish

PINT-SIZE PREDATOR

by Klaus Kallman

inches, resembles a barracuda in miniature. Its elongated snout suggests the beak of a bird. Both jaws are slightly concave, and long pointed teeth are visible in between. The upper jaw is shorter than the lower. The hundreds of sharp teeth are not to tear the prey apart; instead they move slightly back and forth, and their function is to hold and grasp the prey.

Adult *Belonesox* feed mostly on smaller fishes. When hungry, a pike killifish will strike its victim within a split second and usually grab it so that head and tail project on opposite sides of the beak. More rarely, when the prey tries to escape, *Belonesox's* strong jaws will hold it by the tail. With very short and rapid movements of the jaws and slight changes in body position, *Belonesox* maneuvers the victim around until it can be swallowed tail first.

Belonesox is reported to swallow prey one-third its size, but I doubt whether this can be considered normal under natural conditions. Presumably only a starved individual in an aquarium would behave in this way.

Laboratories of Marine Sciences at the New York Aquarium. We are interested in this species as a natural predator of platyfish, which we have studied genetically for more than 30 years. *Belonesox* shows a definite preference for prey below a certain size; when platyfish of different sizes are placed into a tank with *Belonesox*, it is the smaller fish that are taken first. If a second lot of small platyfish is added, it too will be preyed upon before the larger fish. It is important that a sufficient number of small fish are present so that the *Belonesox* does not have to hunt and search for prey. It may not do so in its natural habitat where *Belonesox* is literally surrounded by thousands of prey of all sizes.

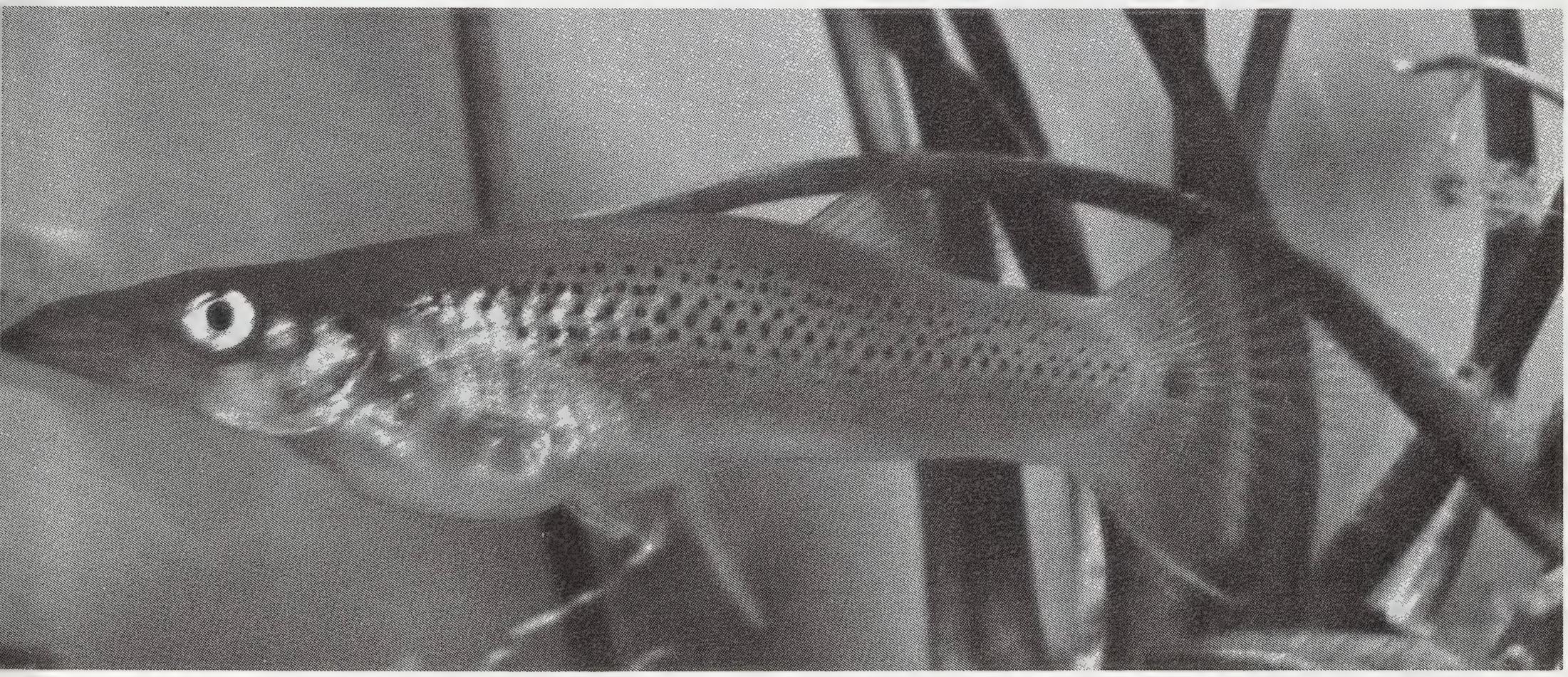
In platyfish the body size and color of the males varies and is largely determined by heredity. Small males reach sexual maturity within three months after they are born, but large males do not mature until they are seven to eight months old. The gene for small size in one of our stocks is closely associated with a gene for brilliant red eyes and gray body, while large size goes together with red body but gray

eyes. Platyfish without any red may be either large or small, while those with both red genes are large and slow-maturing. Without natural selection in our stock, the red-eyed, smaller males will rapidly outbreed the larger ones with red body. We plan to use *Belonesox* in a controlled, highly simplified experiment to determine whether predation can in part explain the pigmentary and size differences of platyfish.

A remarkable change in behavior takes place in platyfish when they are placed with *Belonesox*. Rather than swimming in a normal horizontal position with fins partially folded, they assume a rather odd attitude with dorsal and anal fins spread and erected stiffly, with the head pointing upward, sometimes at a 45 degree angle. One gains the impression that the fish glide rigidly broadside through the water. The significance of this behavior is not known. Perhaps it makes the fish appear larger than they really are and therefore offers a certain degree of protection. Even young platyfish behave like this when placed with *Belonesox* and sometimes maintain this attitude for days. Ultimately they hide in crevices and under roots. Large platyfish in the presence of smaller ones eventually learn that they are not being preyed upon and resume the normal swimming behavior. They will even pass and stop in front of *Belonesox's* mighty snout.

The strike behavior of *Belonesox* seems to be determined by just how hungry it is. A *Belonesox* starved for several days will strike a platyfish within seconds after it is introduced and up to three platyfish may be eaten in rapid succession. Under conditions where prey is abundant, however, only a single fish is taken per day. In such tanks, a *Belonesox* will sometimes take up a position as if to strike but will not do so. The reason for this may be that the "hunger feeling" has not reached a critical threshold in the predator. A sham attack can take place from any direction. The *Belonesox* may be above the potential prey and point straight downward or the approach may take place from either front, behind, or below.

During a sham attack, a *Belonesox* may stalk a platyfish for over 15 minutes, slowly following all the prey's twists and turns. The beak of the *Belonesox* may be within a fraction of an inch of the platyfish but, incredibly, no strike occurs, and the prey does not flee. Instead the platyfish assumes the rather rigid behavior described above and it also tilts its body sideways, away from the *Belonesox*.



The eight-inch-long killifish, *Belonesox belizanus,* is a fierce predator which grasps and holds its prey with its elongated mouthparts, while the victim is maneuvered into position to be shallowed tail first.

Pike killifish swim relatively little and often remain motionless in loose groups for long periods of time. They make no attempt to hide themselves in vegetation. When one strikes or makes a sham attack, several others may follow suit. In nature they often hang motionless under the surface.

Because of its fierce looks and interesting behavior, *Belonesox* is a conversation piece among fish hobbyists. Is it a suitable candidate for the community tank in the livingroom? Most aquarium books do not think so, but I disagree. The secret to its successful maintenance is a large tank so that a *Belonesox* does not ram and damage its snout

against the wall during attacks, and an abundance of smaller prey fish so that slightly larger and more decorative fish are not bothered. One medium-sized platyfish (one-inch) or guppy per *Belonesox* per day is sufficient. We have successfully kept adult *Belonesox* together with swordtails and large platyfish (one-and-a-half inches). The *Belonesox* fed exclusively on smaller platies.

The pike-like body of the adult *Belonesox* is grayish with innumerable small black spots on the flank and a large intensely black mark near the base of the tail fin. When frightened, the body becomes dark and the black spot near the tail disappears. In its place a round white spot, "a negative image," appears of equal size.

The head appears broad and flattened, with a pair of oversized eyes bulging laterally and also somewhat above the roof of the skull. The iris and the skin covering the eyeball contain numerous golden and greenish-yellow pigment cells that iridesce strongly in bright light. It is this golden coloration that gives the *Belonesox* away in nature. Viewed from the bank, the fish are virtually invisible, and they blend in perfectly with the darkness of the water. But the pair of golden eyes seems to project conspicuously above the water. It is an uncanny experience to look at a quiet stream or pool, only to have a dozen golden eyes gaze right back at you. In this respect the *Belonesox* resembles *Anableps,* the four-eyed fish.

Young *Belonesox* appear quite different from adults. I once thought that someone had placed small broken twigs into the aquarium and that they were floating on the surface. They were not twigs, however, but newly born *Belonesox.* Instead of spots, newly born *Belonesox* have a brown stripe that runs the full length of the body, ending in a slightly enlarged knob. They hang motionless under the surface and their resemblance to twigs is amazing. It is quite likely that the coloration together with the lack of movement represents a melanism that enables the young to survive in the presence of the parents. Dr. Charles M. Breder, Jr., former director of the New York Aquarium, and Dr. Donn E. Rosen of the American Museum of Natural History report that when the adults were removed from the tank containing young, the latter left the surface and began to swim about. Upon reintroduction of the parents, the young gradually returned to the surface and resumed their motionless stance.

The pike killifish is a prolific breeder. It becomes sexually mature in five months under aquarium conditions and presumably in less time in nature. As in all poeciliid fishes, the young are born alive; they are slightly larger than three-quarters-of-an-inch. Broods may consist of up to 150 young, and successive broods may be born at roughly five week intervals. Within minutes after birth, the young will hunt and capture other new-born fish.

Because of its great reproductive potential and its predacious habit, *Belonesox* poses a threat to Florida's fish fauna. However, no definitive study has yet been made. It is reported that *Belonesox* can eliminate from stagnant canals the small fishes that are effective in mosquito control. This is clearly not the case in British Honduras and Mexico where even in the smallest bodies of water the pike killifish is always associated with gambusia and other small fishes.

I suspect that *Belonesox* competes with other predators in Florida and that ultimately the size of its population will be determined by the abundance of prey. *Belonesox* itself is preyed upon by larger fish. Also its habit of standing near the surface with the telltale golden iridescent eyes would seem to make *Belonesox* an easy mark for a variety of bird predators.

Introduced into the freshwaters of southern Florida, the pike killifish is native to Central America. Dr. Kallman collected *Belonesox* in this area of British Honduras (below).

Mole Salamanders

PART II *by John L. Behler, Jr.*

The creature above is the larva of the tiger salamander, a mole salamander found through much of North America.

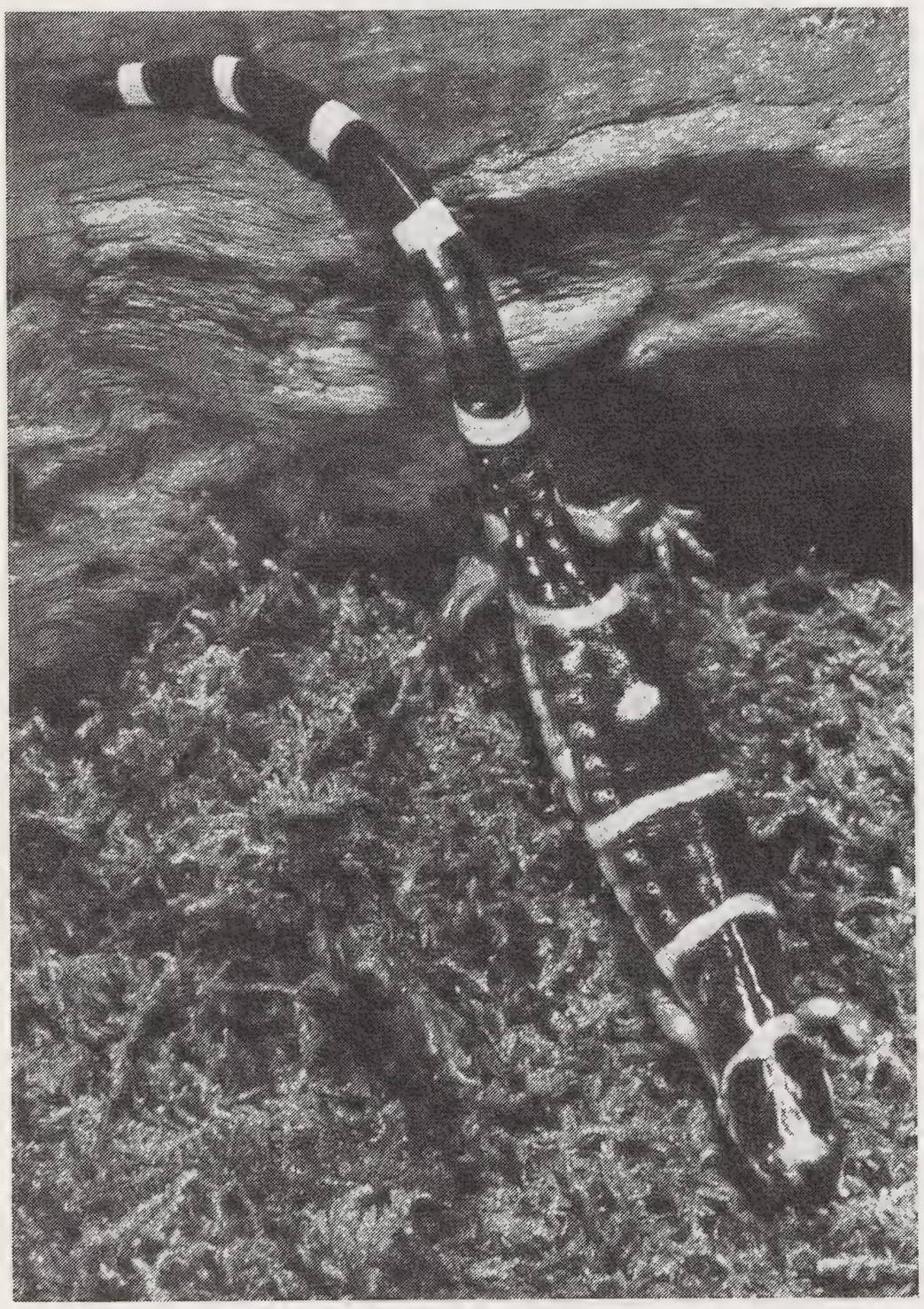
An early October downpour swells a tiny streamlet and leaves it coursing through a narrow strip of California's humid coastal forest. Nearby hillsides are covered with a tangle of low shrubs and sword fern. Here and there immature redwood and Port Orford cedar push above the dense undergrowth. A small white-footed mouse scurries about rotting logs and other logging refuse in search of the season's crop of berries and seeds. A half dozen yards away, a spring empties into the passing brook. Here, Pacific giant salamanders have gathered to feed on an assortment of insects, snails, other amphibians, and an occasional mouse or shrew. As the days become shorter and temperatures begin to drop, these powerful mole salamanders abandon their temporary retreats at the water's edge and burrow deeply into the debris at the base of the spring.

The Pacific giant salamander *(Dicamptodon ensatus)* is a sturdily built, blunt snouted amphibian, and like its eastern relatives, the marbled and spotted salamanders, belongs to the Ambystomidae – the mole salamander family. This western salamander is found primarily in damp coastal forests of the Pacific Northwest. Scattered populations occur from southwestern British Columbia to central California, and several additional colonies have been discovered in the Rocky Mountains of Idaho and Montana.

As its name implies, the giant salamander is remarkably large. The adults, heavy-bodied and appearing quite clumsy, may reach a length of nearly 12 inches. Although small compared to several of the aquatic salamander species, the giant salamander and its relative the tiger salamander vie for the distinction of being the world's largest terrestrial salamander.

Contrary to typical mole salamander behavior, the Pacific giant salamander climbs quite well and occasionally is found several feet above the ground on the bark of sloping trees. In such a situation, the camouflaging effect of its reddish or purplish brown body color, broken by an irregular black marbling pattern, would undoubtedly deceive most of its enemies. If the giant salamander is disturbed, however, its peculiar ability to produce low pitched rattling or even screaming sounds – depending on the degree of irritation – may discourage its molester.

The ringed salamander *(Ambystoma annulatum)* is only observed in numbers after the autumn rains have sent them to their breeding ponds. The center of this secretive species' limited range is located at the junction of the Missouri, Arkansas, and Oklahoma borders.



As a mole salamander, the Pacific giant salamander spends a large percentage of its adult life in subterranean existence and relatively little is known of its natural history. However, unlike most of the mole salamanders, which leave winter retreats and migrate in great numbers to breeding ponds each spring, the giant salamanders remain submerged and establish a subterranean nest alongside a spring or stream. Courtship, mating, and egg-laying apparently take place in late March or April. Eighty or more yolk-laden eggs are deposited in underground pools.

Egg development proceeds slowly through the summer, and during the autumn, the larvae break free from their egg capsules. Several months later, they appear in the open stream. Water beetles, caddisfly larvae, snails, and a wide variety of small invertebrate prey make up the menu of the developing larvae. By their second summer, the larval giant salamanders have attained a length of six to eight inches and are capable of overpowering small crayfish and smaller salamanders.

Robert Stebbins in *Amphibians of Western North America* reports that larvae sometimes can be lifted from the water with their jaws stubbornly clamped on a piece of bait. Adults, too, display this trait, as eight-inch long Pacific giant salamanders have been observed tenaciously holding on to garter snakes two feet in length.

In the normal course of events, the larvae experience metamorphosis to the terrestrial adult during their second summer. Occasionally, however, this species, like several other salamanders, retains gills and tail fins and continues an aquatic existence. Increasing in length to perhaps 12 inches, the aquatic version of the Pacific giant salamander may remain as a larvae throughout its life span, but carry on all adult functions.

The two additional United States mole salamander genera, *Rhyacotriton* and *Ambystoma,* also inhabit the Pacific coastal forest. *Rhyacotriton* has but a single species *(R. olympicus),* which ranges from the Olympic Peninsula of northwestern Washington south along the coast into northern California. Olympic salamanders, as they are commonly called, differ considerably in color pattern. Individuals from western Washington and northwestern Oregon typically are chocolate-brown above, with an orange or yellow belly. The second subspecies, described from northern California and southwestern Oregon, has a mottled olive back and a black-spotted olive-yellow undersurface. The Olympic salamander in contrast to the large physical proportions of its relative, the Pacific giant salamander, averages a mere three-and-a-half inches in length. Like its relative, this big-eyed species lives in spring seepages or among loose pebbles and moss-covered rubble in the shallows of cold mountain streams.

This small ambystomid is unique in the family in lacking nasal bones. It also possesses a short tail and eyes which are proportionately larger than those of

other family members. The male is recognized by squarish lobes at the sides of the vent. Additionally, investigators have found that the lungs of the Olympic salamander are less than one-quarter-inch in length, highly vascularized, and filled with air. Although functional, the minute structures obviously limit the species' existence to springs or to the cold, highly oxygenated water of cascading mountain streams. In these situations, effective respiration – through the skin and lining of the mouth and pharynx – is possible.

The Olympic salamander's habitat is frequently shared with the tailed frog *(Ascaphus truei),* America's most primitive frog. Highly modified for existence in swift mountain streams, the male of this species bears a tail-like structure which permits fertilization to take place internally. Existing together, the tailed frog and the Olympic salamander somehow compete successfully for the stream's supply of springtails, amphipods, and stonefly nymphs.

Unlike the frog, which seldom leaves the water, *Rhyacotriton* ventures out on the moss-covered

Reaching a length of more than seven inches, the northwestern salamander frequents the humid Pacific coast from northern California to southeastern Alaska. When molested, this species secretes a sticky white poison from the conspicuous parotid glands on its head. It belongs to the genus *Ambystoma.*

talus, along the stream's splash zone to rest and to forage. When startled, it beats a hasty retreat back to the security of the stream.

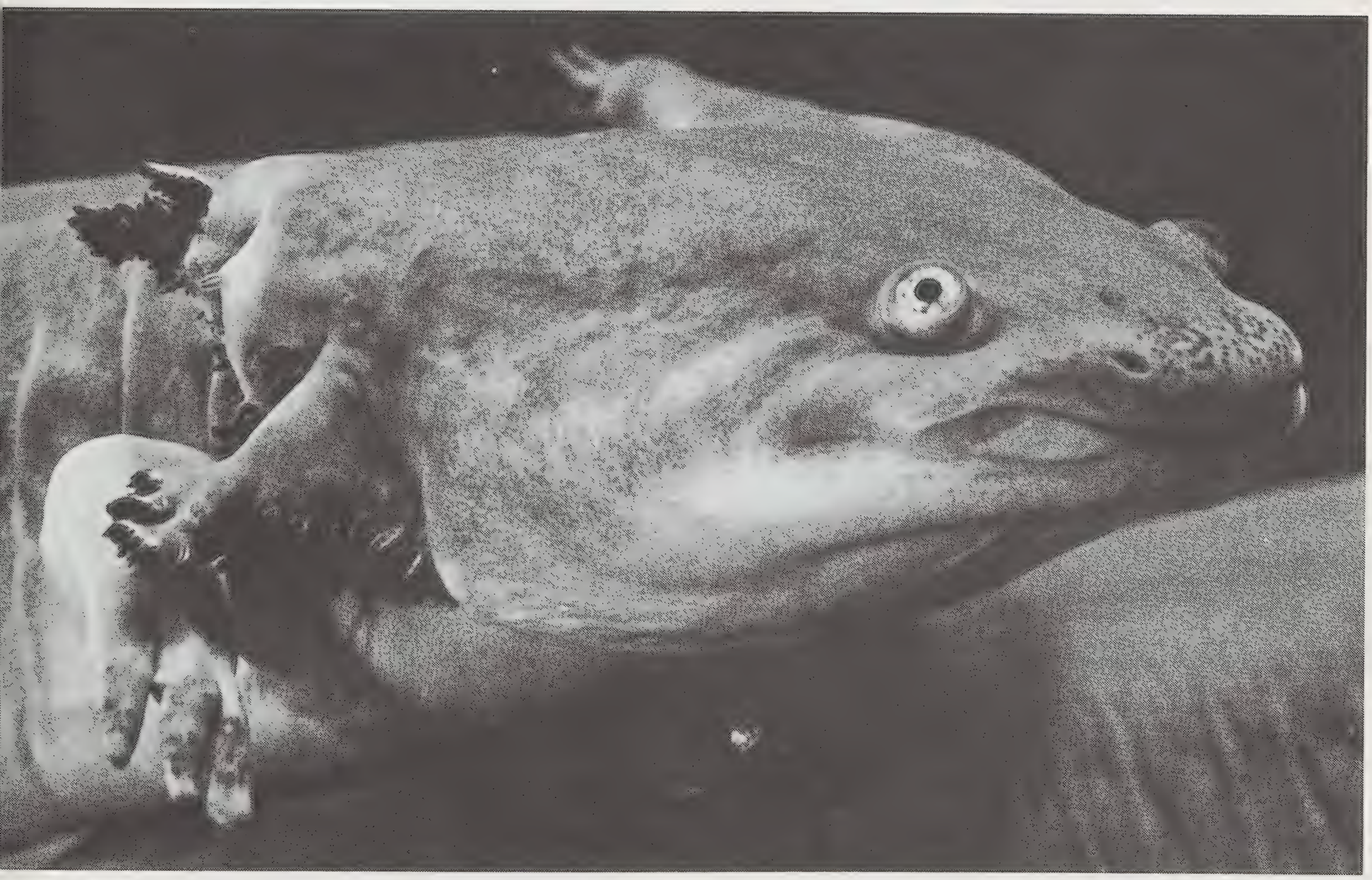
The reproductive biology of the Olympic salamander is poorly known. It apparently breeds in spring or early summer, and the eggs, which number less than a dozen, are singly attached to the lower surface of stones. The "stream type" larvae of this mole salamander resemble those of the Pacific giant salamander. Compared to the "pond type" larvae of other ambystomids, which have broad fins and long plumelike gills, this larval form is specialized for life in moving water. Much more streamlined in appearance, its gills and tail fins are markedly reduced.

The members of the third genus, *Ambystoma,* are distributed on the Pacific coast from southeastern Alaska south throughout most of the United States, and the Sierra Madre Occidental and central plateau of Mexico.

In the western states, the relatively drab olive and brown eastern form of tiger salamander, the largest ambystomid, is replaced by subspecies bearing white, cream, or yellow spots or bars on a black background. In many of these western subspecies, metamorphosis frequently fails to take place. The larvae retain their plumose gills and increase in size to more than 13 inches in length. These neotenous larvae usually are referred to as "axolotls".

Only 300 species of salamanders exist today, 32 of these the mole salamanders. To date, five mole salamanders – three Mexican and two North American forms – are included on the International Union for the Conservation of Nature and Natural Resource's List of Rare and Endangered Amphibians and Reptiles. These, because of their very limited distribution, could easily join the legions of the extinct if they are suddenly faced with overexploitation or a change in their habitat.

The young of many of the western subspecies of tiger salamander often fail to undergo metamorphosis. When this occurs, the salamander retains its larval form, and is commonly called the axolotl.



The neotenic form of the tiger salamander continues to lead an aquatic existence, rather than becoming a terrestrial form like those tiger salamanders that undergo metamorphosis. The gills of the neotenous larva, visible as feathery structures behind the head, are quite prominent.

animal kingdom

REPORTS

WHAT'S A TAWNY FROGMOUTH?

This big-mouthed bird has the uncommon name of tawny frogmouth. When the chick hatched at the Bronx Zoo March 27, under the watchful eyes of Associate Curator Joseph Bell of the zoo's Department of Ornithology, it registered 22.3 grams; one month later, it weighed slightly over 300 grams and was still growing.

The chick is now adult-size and has been placed on exhibition in the large Bird House, where it can be distinguished from its parents by its wide-eyed, head-bobbing curiosity, in comparison with their stately and stationary behavior.

Known and named for its enormous gape of mouth, the tawny frogmouth is native to Australia. A forest bird, it feeds at night on insects, scorpions, snails, frogs, mice, small birds, and occasionally fruit. An adult bird bears an uncanny resemblance to weathered bark and is often mistaken for a projecting broken branch of a tree.

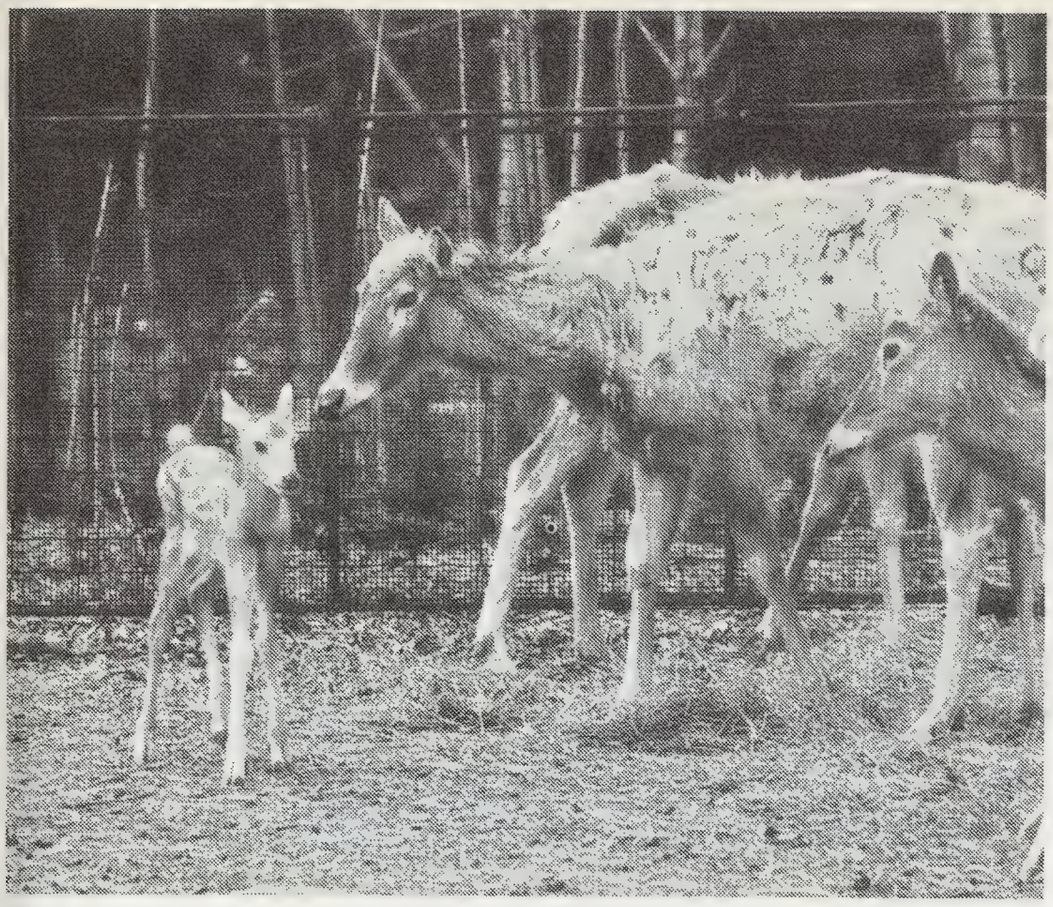
The Bronx Zoo's birds were a gift of the Taronga Park Zoo in Sydney, Australia.

AQUARIUM CALLS FOR VOLUNTEERS

Want to get your feet wet? The New York Aquarium at Coney Island is in need of volunteers for its educational programs to start this summer. Anyone interested in offering his services should contact Mr. Martin Grey, Administrative Assistant to the Director, at the aquarium; the phone number is (212) 266-8500.

A WHALE OF A SHOW

The sign at the New York Aquarium may say "Dolphin Show," but that is a white whale leaping for the ball at the whistled instructions of aquarium trainer, Austin McDevitt. "Alex" is the first trained white whale (also known as beluga) in captivity, and Mr. McDevitt is preparing his apt pupil – as well as several white-sided dolphins – for a summer of performances at Coney Island.



IT'S A RARE SIGHT

A male fawn, born April 30, brings the number of Pere David deer at the Bronx Zoo to 17 animals. Often called "the world's rarest deer," the species is extinct in the wild in its native China. It exists today only in zoological gardens, and according to Curator of Mammals Hugh B. House, the total number of animals is probably less than 600.

The Pere David is a moderately large deer, adult males standing about three feet nine inches in height. The species first became known to the western world in 1865, when Pere (Father) Armand David, a French missionary-naturalist, saw the remnant herd in the Imperial Hunting Park in Peking, all that remained of the numbers once distributed over northeastern China.

In 1869 a young pair was sent to the London Zoo as the gift of Sir Rutherford Alcock, British Minister at Peking. These were the first living specimens to be seen in Europe.

The herd in China was killed during the Boxer Rebellion in 1900, leaving only scattered specimens in European institutions and a few in Peking, where the last died in 1921.

Fortunately, in 1898, the eleventh Duke of Bedford had established 18 specimens at Woburn Abbey, a walled park of approximately 4,000 acres, in England. This herd thrived and in 1948 numbered 300 animals. From this nucleus, breeding pairs were acquired by many of the world's larger zoos, and the species was returned to China in 1956, when the Peking Zoological Garden received four specimens from England's Whipsnade Park.

The first examples in the United States were two pair received at the Bronx Zoo in 1946. The zoo's first fawn was born in 1949, and there has been regular breeding to date.

THE bookshelf

THE WINTER OF THE FISHER. By Cameron Lansford. 232 pages. W. W. Norton & Co., New York, 1971, $5.95.

In 1952, at the age of 24, Cameron Langford was injured in an automobile accident which left him paralyzed from the shoulders down. Even though unable to use seventy-five percent of his body, he continued for some years to work full-time from his wheel chair as a radio announcer and advertising writer. With the help of mechanical aids, many of which he invented himself, he was able to enjoy such varied hobbies as painting, photography, and raising tropical fish.

Mr. Langford, born and educated in Canada, had always been deeply interested in natural history and after his accident he immersed himself in the subject, particularly in the wildlife and terrain of the north wilderness.

Out of this interest came his beautiful and moving book, *The Winter of the Fisher.*

I am not a fan of fictional tales about animals. Most leave me cold. Most are either gushing with sentimentality or they humanize their animal characters to the point where the bunny rabbits and the foxes should be wearing pants. Many of these books, too, paint inaccurate pictures of the relationships between wild creatures.

Cameron Langford's powerful work evades these pitfalls, for the main, at least. You can feel the life-beat of the northern forests in this book, and while you may identify strongly with the fisher, there is no question that it is a wild beast, not a mustelid Peter Rabbit.

The portraits of the old Indian and the trapper, who enter into the fisher's struggle for survival, are so excellent it makes one wonder how well Langford would do with a work of non-animal fiction. But we never will know.

The manuscript of *The Winter of the Fisher* was just completed when Cameron Langford died in 1970, at the age of 42. He had already begun work on his next book about the snowy owl.

E.R.R.

NOTE: The following two reports are not book reviews, but rather information on books written by New York Zoological Society staff members, Joseph A. Davis and Edward R. Ricciuti, which may be of interest to society members and friends.

FIVE HUNDRED ANIMALS FROM A TO Z. Illustrated by Tibor Gergely. Text by Joseph A. Davis. American Heritage, New York, 1970. $4.95.

Five hundred animals, vertebrate and invertebrate, are depicted in delightful color. The pictures will appeal to the Sesame Street set, while older children will find the brief text treatments easy to read and informative. Mr. Davis has managed to find an interesting fact or two about everything from aardvark (*all* animal alphabets have to begin with aardvark) and abalone to zorille, including such little-known creatures as the yapok, opaleye, limpet, and anhinga. A conservationist's concern for what man is doing is evident throughout the text.

SHELF PETS. By Edward R. Ricciuti. Photographs by Arline Strong. Harper and Row, New York, 1971. $4.50.

Shelf Pets provides information on how to maintain a variety of small animals—ranging from crickets to guinea pigs—that do not require a great amount of space. The book stresses that keeping a wild creature is a tremendous responsibility, and also that many wild animals should not be kept as pets, because of their rarity, maintenance requirements, or other characteristics that make them unsuitable.

Shelf Pets is designed for the city dweller as well as the suburbanite or countryman. It tells where and how to find animals in nature and provides advice on what to buy—and what not to purchase—from pet shops. It suggests that animals taken from the wild can be observed for a while, and then released, but only at the place they were found.

All of the animals in *Shelf Pets* can be maintained with resources available to the average layman.

The book is illustrated with black-and-white photographs, including portraits of many of the creatures discussed.

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ILLUSTRATION CREDITS

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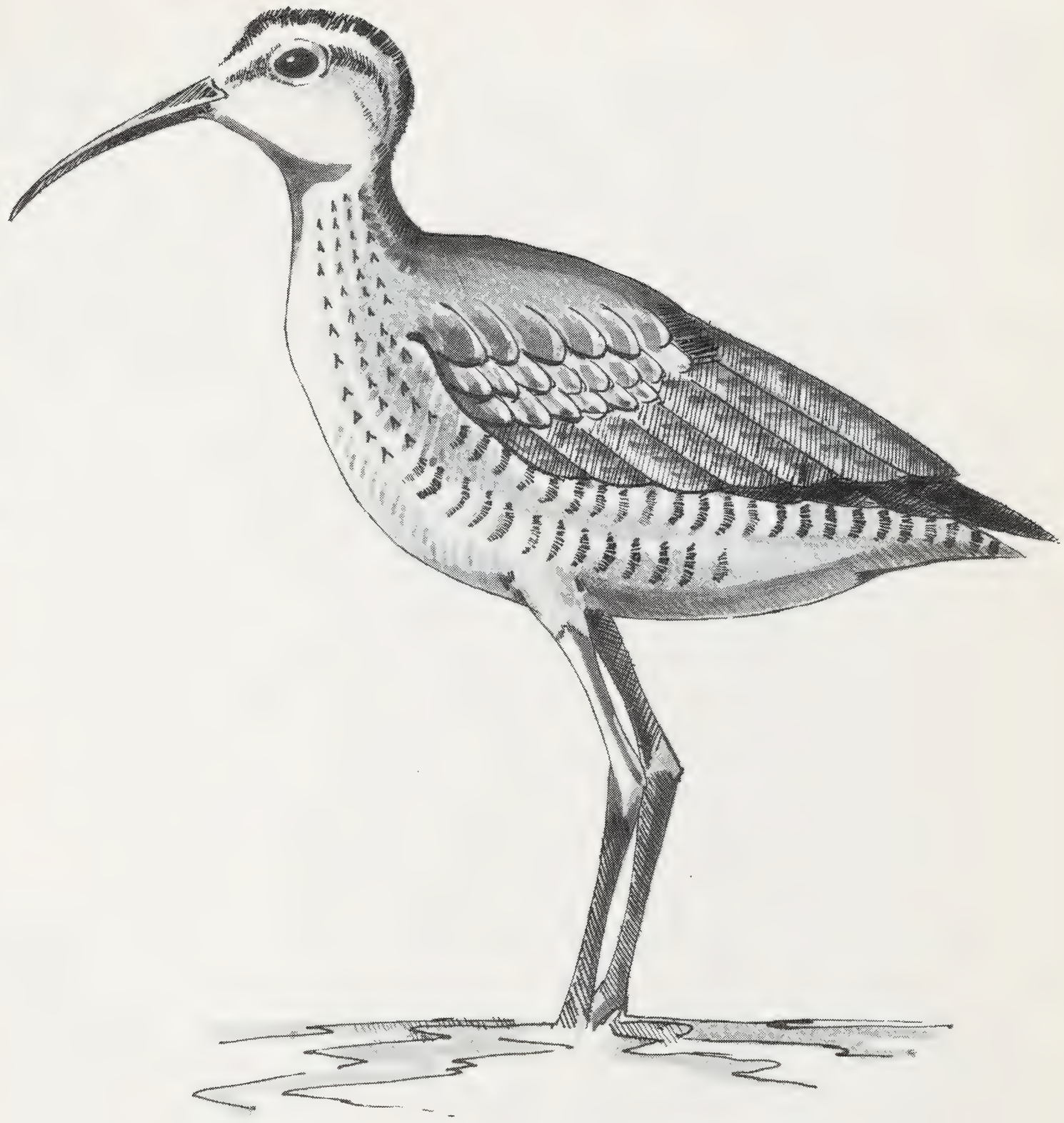
dying species...

"The beauty and genius of a work of art may be reconceived though its first material expression be destroyed; a vanished harmony may yet again inspire the composer; but when the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can be again."

William Beebe
First curator of birds, Bronx Zoo



ESKIMO CURLEW
Numenius borealis

The Eskimo curlew, which once migrated in huge flocks from the Arctic to South America, is today so rare that not a single specimen has been reported since 1963. In September of that year, one of these foot-long birds was shot on the island of Barbados – an event which well might be the passing of the last Eskimo curlew.

The previous April, one of these birds was seen at Rockport, Texas, and in April 1962, three or four Eskimo curlews were seen and photographed on Galveston Island, Texas.

The events that brought this brownish shore bird to the brink of extinction – and quite possibly over the brink – began in the middle of the last century.

The Eskimo curlew bred from the Mackenzie district of Canada west to Norton Sound, Alaska, and wintered on the pampas of southern Brazil, Paraguay, and Argentina.

The fall migration route was along the eastern seaboard of North America and across the Gulf of Mexico. In spring the curlews flew directly across the Gulf, over Texas, and north across the Great Plains.

Migrant Eskimo curlews could be seen on grasslands, in the company of larger plovers and whimbrel. The call of the curlew is said to resemble that of the bluebird and thus immediately makes it recognizable from any of the plovers it may be with. The bird feeds mainly on berries, snails, insects, and other invertebrates.

The birds were not molested by man at their breeding grounds but were slaughtered on migration and at their wintering areas. Heavy hunting occurred in Canada's Maritime Provinces and in New England, as the birds moved south along the United States coastline. One record indicates that over 7,000 birds were killed in one day in 1863 on Nantucket Island.

By the 1870s a big slump began, and by the mid 1880s no really large flocks of these birds were noted, although there are long lists of specimens and sightings made in the early 1900s. However, even sightings of single birds continued to decrease and by the late 1950s, only a few sightings, and those only "probable," were listed.

The Red Data Book of the International Union for the Conservation of Nature lists the current status of the Eskimo curlew as "Apparently very rare; breeding and wintering grounds unknown and perhaps nearing extinction." These birds have been protected for many years in both the United States and Canada, but have not received similar protection all along their migration routes and on their wintering grounds.

The mass slaughter in the mid 1800s was undoubtedly a significant factor in the decline of the Eskimo curlew. However, at the same time that the slaughter was occuring, vast areas of grassland along the migration routes in the southern United States and in the Great Plains States were being converted to cultivated farmland. This same phenomenon also occurred in large areas of the wintering grounds as well. With the great decrease in available habitat, the flocks of curlews were confined to smaller areas and became even more vulnerable.

The combination of decreasing habitat and heavy hunting for at least nine months of the year likely has spelled the end for the Eskimo curlew.

DONALD BRUNING

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MAGAZINE OF THE NEW YORK ZOOLOGICAL SOCIETY VOL. LXXIV, NO. 4 AUGUST, 1971

ABOUT THE COVER

Front: Magellanic penguins *(Spheniscus magellanicus)* congregate at Punta Tombo in Argentina in colonies that number more than 200,000. For an unusual report on an expedition to these shores, see "Predation on Penguins at Punta Tombo," by William G. Conway, on page 2.

Back: Formosan sika *(Cervus nippon taiouanus)* is a small forest deer, with a shoulder height of about 35 inches. At the Bronx Zoo, a mother nuzzles her newborn fawn on exhibit at the Deer Range.

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PREDATION ON PENGUINS

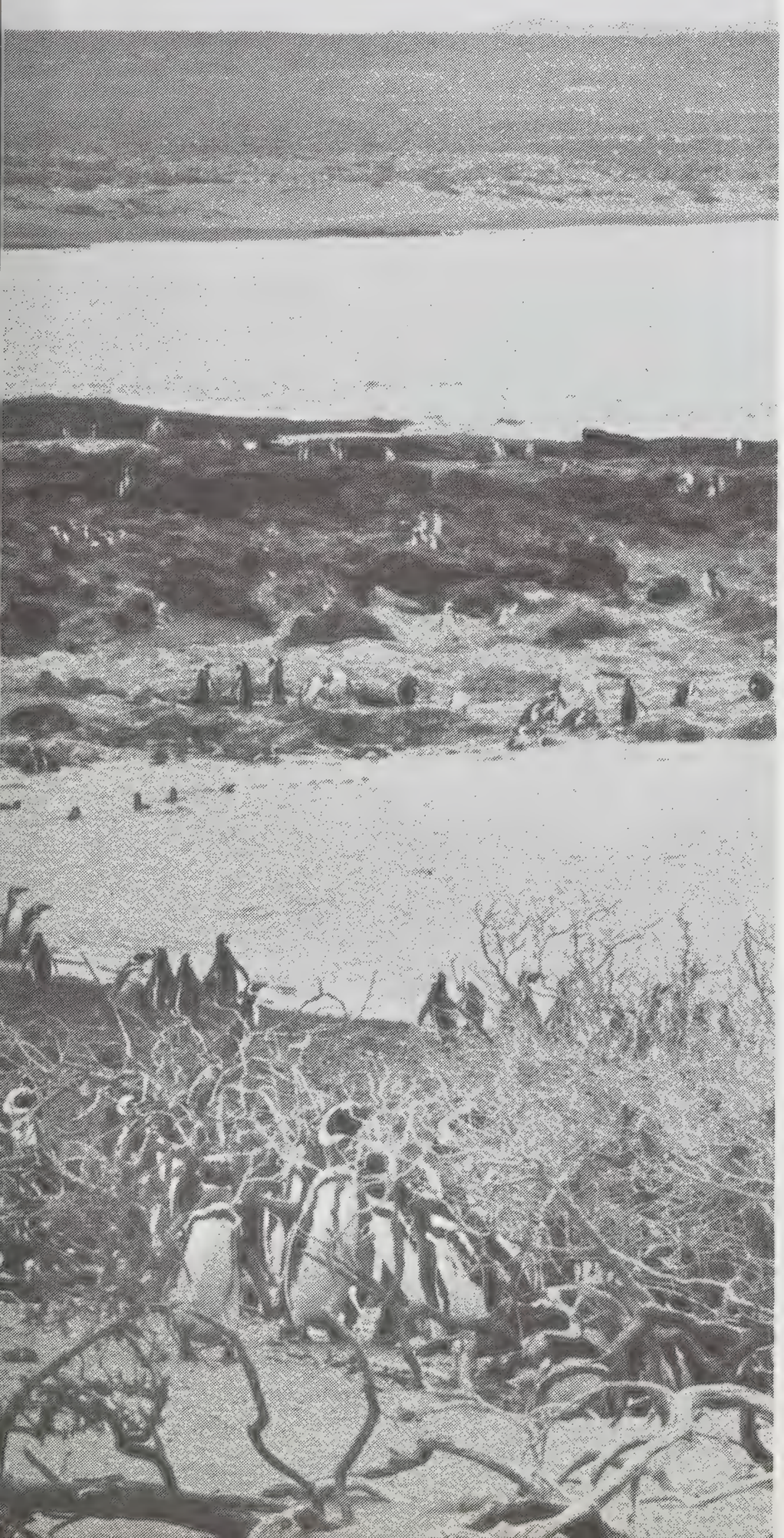
at Punta Tombo

by William G. Conway

Patagonia's arid hills stretch into the distance behind the Magellanic penguin colony at Tombo Bay.

An unusual report from the 1969-70 Patagonian expedition led by New York Zoological Society President Robert G. Goelet

A bull Patagonian sea lion poses before its harem (right). The species is common near Punta Tombo.



Magellanic penguins *(Spheniscus magellanicus)* inhabit both coasts of South America, living as far north as southern Chile and southern Brazil. They eat fish, crustaceans, and squid, and in turn are eaten at every stage of their life cycle by a variety of animals. By chance, I was able to add the Patagonian sea lion to this list of penguin predators while observing the penguins in Argentina.

As Christmas approaches in New York, at the opposite end of the hemisphere, in Argentina, Patagonian sea lions assemble their harems and Magellanic penguins colonize promontories along the shore. These promontories are used year after year by both species for breeding. On the coast of the province of Chubut, the penguins gather in spectacular numbers at Punta Tombo, which is only a little closer to the South Pole than New York is to the North Pole.

Punta Tombo is nothing but a rock-and-sand spit protruding two miles into the icy Falkland Current of the south Atlantic, but each austral spring more than 200,000 Magellanic penguins congregate there. They return, as they always have, to find mates, to rear their young, and to seek food in the nearby sea—where they are themselves sought by other predators.

On every side, Punta Tombo's rocks reverberate with the hoarse cries of the adult penguins. Thousands upon thousands of fuzzy, squeaking chicks peer out from nests under thorny bushes or in burrows. The vast numbers of chicks and young seem to prove the success of the effort to reproduce, but their carcasses and skeletons by the hundreds bear witness to the pressure of selection and the cost at which reproductive success is achieved. The day after Christmas in 1969, I witnessed an extraordinarily dramatic episode in the penguin's struggle to survive.

It was the last day of my second trip to Tombo (see "The Penguin Metropolis at Punta Tombo," *Animal Kingdom,* August 1965, and "A Close Look at Argentine Wildlife," *Animal Kingdom,* October 1965) when I settled myself on the windswept shingle beach to photograph penguins swimming in the surf.

A plastic bag covered the camera to protect it from the salt spray. I punched a hole through the bag to the viewer, removed the protective cap from the 400mm lens, and took light-exposure readings from the birds standing all about me. Meanwhile, a young penguin walked up and pecked curiously at my shoe. I memorized shutter speeds and lens apertures for subjects swimming in the water nearby and far out, then repeated the process and checked the effect of a passing cloud. When something of special interest happens in the field, camera fumbles are the ultimate in frustration.

Suddenly, in the water just beyond the foam of the furthermost breakers, two huge sooty-colored giant petrels *(Macronectes giganteus)* thrashed about in a violent, twisting tug-of-war. Mist and spray shrouded their prize, and the surf drowned their cries—if there were any. Abruptly, bright blood stained the gray-green waters between the petrels, and a penguin's flipper stretched up and was still. I realized that penguins were the victims of the small violent knots of *Macronectes* that I had been watching for days, too far at sea for me to discern their prey.

Binoculars now revealed four more groups of giant petrels tearing at catches further out, and each had a penguin. This activity explained the presence of the sinister-looking "stinkers," as sailors sometimes call giant petrels, so far from their breeding areas on Tristan da Cunha and various sub-antarctic islands far to the south.

As the drama of the petrels and the penguins unfolded, the penguins' disinterest in the predators seemed curious. The dark hump-backed petrels glided majestically over the waters on both sides of Tombo and out over the Atlantic as far as I could see. The big birds have a wingspread of more than six feet and may weigh up to nine pounds. But the penguins, standing all around me on the shore, showed no obvious reaction as the predatory birds sailed over. I could not determine whether penguins in the water were more observant and attempted any sort of evasive action. (Of course, zebras and

A newly hatched penguin chick lies disembowled near the nest of a blackbacked gull.

Giant petrels squabble over a dying penguin (left).

The Patagonian fox is thought to be another penguin predator.

antelope in Africa seem to distinguish between lions that are hunting and those that are not.)

In the two kills seen most clearly, it appeared that the petrels had over-powered perfectly healthy free-swimming penguins. At first, my attention was drawn by a sudden congregation of kelp gulls fluttering over the petrels, waiting for fragments of the feast as the big birds twisted their prey into pieces small enough to swallow.

Much later, after seeing many struggles which had started unobserved, I saw a large petrel suddenly drive forward from where it was swimming and strike with its beak, grasping a penguin. Within seconds, a smaller darker petrel, probably immature, had joined it and the now familiar struggle and kill were underway.

I did not see a kill in which a single petrel dispatched its prey alone, but somehow the mode of attack seemed unlikely. One might expect kills to be made after a plunge from the air. Immature penguins ought to be the easiest prey, but most victims in the petrel's beaks whose age I could ascertain appeared to be adults. However, only an extensive study could reveal the true proportions of adults and young in the petrel's food.

Food is all a penguin means to a petrel, of course. Like most animal predators, the petrel kills and eats other animals out of necessity—not from greed, not from stupidity, and not for fun. Undoubtedly, the petrel's attitude toward the penguin is as dispassionate as that of the penguin to a fish or a robin to a worm.

Not being a petrel, and very glad not to be a penguin for the moment, I braced my notebook on the camera's tripod and summarized a few observations on penguin predation at Tombo while keeping an eye out for further opportunities to photograph attacks.

Mummified chick carcasses and half-eaten remains are everywhere on Punta Tombo. I had paced off a 50-yard portion of the sea wrack in only one small inlet on the north side of Tombo and counted the remains of 137 penguins, adult and fully fledged. Some bodies were whole, as though their deaths might be attributed to disease but they were few in number. Others were mangled and substantially eaten, but this might have happened after death.

While waiting with my camera on the shore, I listed the animals that I knew preyed upon penguins at Tombo and those I suspected did so because of their reputations elsewhere. All are birds but one: the local fox. I have not seen evidence that this handsome long-legged fox eats penguins, but it does frequent the area and it would be surprising if the fox occasionally did not take a chick. Probably, there are other predatory mammals about as well. In 1964, my wife, Christa, found the skull of a small weasel-like mammal, resembling a grison, which is a possible candidate for the list of penguin predators. In any event, the penguin-eaters of Tombo can be subdivided by their habits and capabilities.

First, there are the egg-eaters. These include the skua *(Catharacta skua),* the kelp gull *(Larus dominicanus),* the dolphin gull *(Leucophaeus scoresbii),* and the sheathbill *(Chionis alba).* Of these, the skua is by far the boldest and a scourge of penguin eggs and chicks. The rest probably concentrate on snatching eggs from the relatively weakly-guarded cormorant colonies on Tombo's tip. I have watched dolphin gulls robbing the nests of even their big cousins, the kelp gulls. Wherever soil conditions

A skua, looking the predator it is, stands near its nest at Tombo.

permit, however, the penguins dig burrows for their nests and their eggs then are safe as long as the parents are on guard at home.

A second grouping of "penguinivores" are the chick-eaters. I saw skuas and kelp gulls eating very small penguin chicks. Both birds can capture the downy little chicks if they are small and unattended. So, probably, will the native fox. I saw no evidence that giant petrels ventured into the colony.

When I made my first notes, about 10:00 A.M., giant petrels were the only observable members of the third grouping of penguin-eaters at Tombo: those that prey on adults and young mature enough to take to the water. This situation was to change.

Almost all the penguin-eaters I have listed also act as scavengers. For example, the little sheathbills feed upon the remains of penguins left by the stronger predators, as well as penguins that are

The pigeon-like sheathbill is a scavenger that preys on eggs and the smallest of penguin chicks.

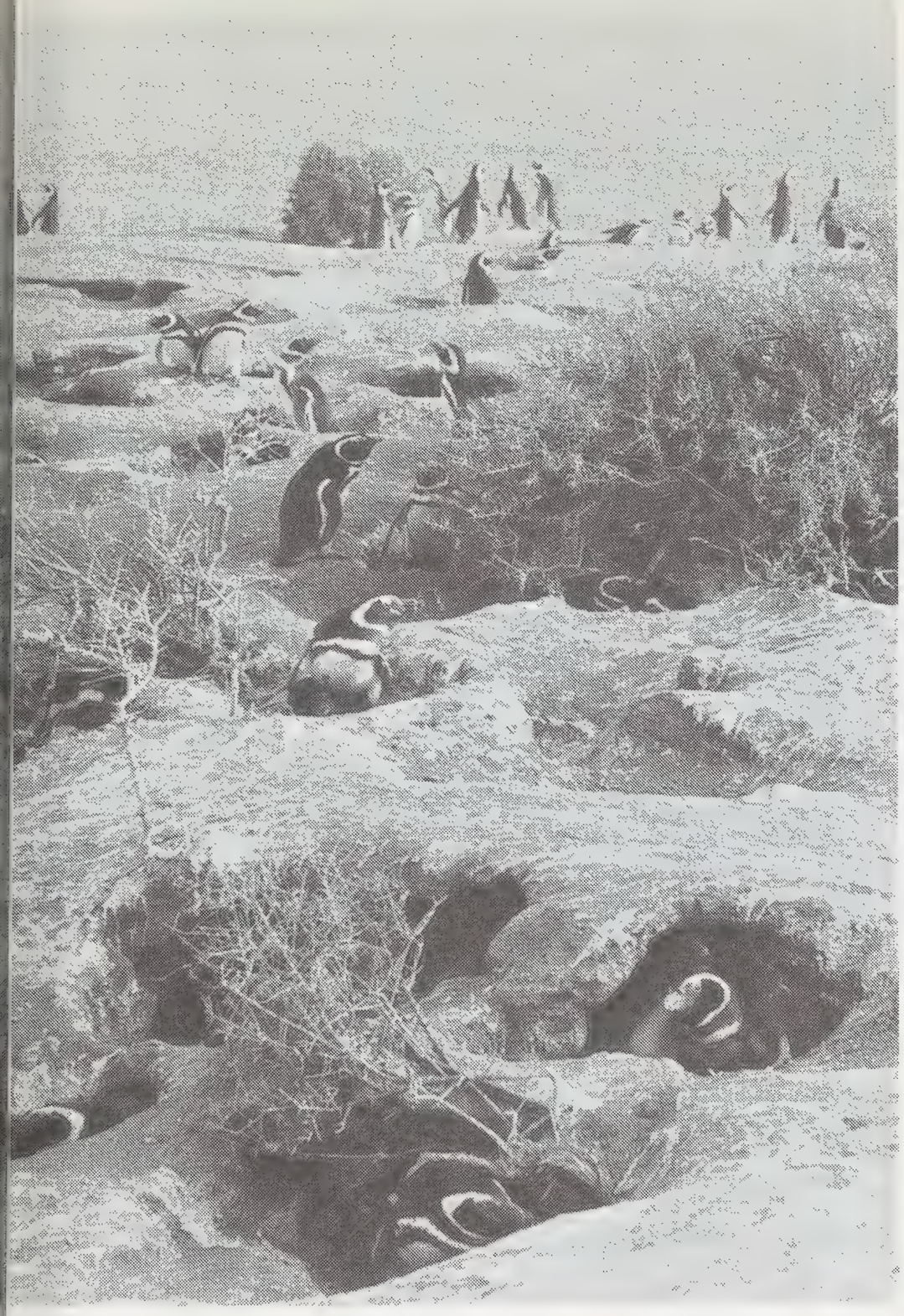
victims of other causes. The six or seven possible predators on eggs, chicks, and adult penguins might seem enough to form a serious threat to the survival of the birds, but the role of predation in regulating an animal's population is very much in debate. It varies greatly with the species and the circumstances.

Food supply and predation are both of importance to an animal's numbers, but food seems far more critical in most cases. In fact, some studies suggest that predators have very little affect upon most animal populations; predators eat the sick, the weak, and the surplus almost exclusively. While it is clear that sick or weak animals have little chance of surviving when large predator populations are at hand, it also has been shown that predators often take healthy animals in their prime.

There is reason to believe that many species have potential population control mechanisms within their genetic make-up. Territorial behavior, in its intra- and inter-specific manifestations, is an example of this type of mechanism. It has not been proven that such mechanisms have evolved independently of an environmental factor like food supply. Ovulation in white-tailed deer in the United States, for example, has been shown to be dependent upon the level of nutrition.

A relationship between food supply and reproduction has been shown among African elephants in Africa's Tsavo and Murchison Falls parks. Overabundance of the elephants has caused destruction of food supplies in some areas. This has been followed in these localities by an increased calf mortality and longer interval between calving on the part of the elephants. In addition, the elephants seem to reach puberty at a later age.

During the 1930s, a fascinating predator-prey experiment was conducted in several New York woodlands on the effect of the removal of ruffed



Unlike many penguins which nest in the open, the Magellanic penguin protects its eggs and chicks in a burrow.

grouse predators upon populations of the bird. Predators were removed from two areas and left in two others as a control.

Careful studies then were made of losses in grouse nests, of chicks, and of adults in both experimental and control sites. In the experimental areas 24% to 29% of the nests were destroyed, whereas 51% to 72% of the nests in the control areas were lost. Chick mortality was 54% to 57% in experimental areas and only a little higher, 55% to 67% in the control areas. Interestingly enough, losses of the adult grouse were larger in the areas without predators.

Predator-prey relationships are not simple even though too many sportsmen and farmers who should know better often think so. To these people, predators are "varmints" and killing them is a pleasure and a duty lest they kill the grouse, the quail, the rabbits, the sheep, or the chickens. It is difficult to reconcile this commonly-held view with the fact that before man's intervention many more viable populations of game animals existed amid many more predators than is now the case.

The complexity of predator-prey relationships, therefore, make it difficult to determine the importance of predation among penguins.

In South Africa, about 40% of the eggs of the black-footed penguin *(Spheniscus demersus),* closely related to the Magellanic penguin, reportedly are devoured by ibises and gulls. Predation by skuas in Adelie Land of the Antarctic is said to account for the destruction of 70% of the eggs and young of the Adelie penguin.

In the course of my reflection and intermittent picture-taking at Punta Tombo, I was satisfied that I had probably listed the principal penguin predators observed on that coast. By mid-afternoon, a party of Patagonian sea lions was swimming far out toward the point of the promontory. The wind had increased and Robert G. Goelet, who led our expedition, and Argentine naturalist Jaime Llavallol could be seen carefully working their way toward

A bull sea lion surfaces after disembowling an adult penguin in the surf off Punta Tombo.

camp through the penguins' colony. The penguins, accustomed to my presence, had gathered closely about me, resting, preening, and occasionally braying in "ecstatic" display. Small parties of the birds streamed into the water, and each new wave that sizzled onto the shingle deposited others on the shore. Then, all at once, the continuity was broken.

The birds about me suddenly started back from the water, craning their necks toward the sea as though of one mind. Fifty yards out, a great brown head broke the surface with a penguin in its mouth. With one incredibly powerful wrench, it tore the bird almost in half. It was a bull Patagonian sea lion *(Otaria bryonia),* an animal that can weigh a thousand pounds. Kelp gulls immediately descended on the fragments of the feast. Meanwhile, the sea lion grasped the larger part of the carcass and wrested off another huge mouthful, and then one more. Giant petrels winged in, claiming the remainder as the sea lion lost interest and disappeared.

Only one quick picture had been possible. Then, within minutes, the kill was repeated before my eyes. This time, alerted by the actions of the penguins sharing the beach with me, I managed a picture at the exact instant the new victim was ripped apart and its carcass hit the water. In rapid succession two more kills were made, but both too far away to photograph.

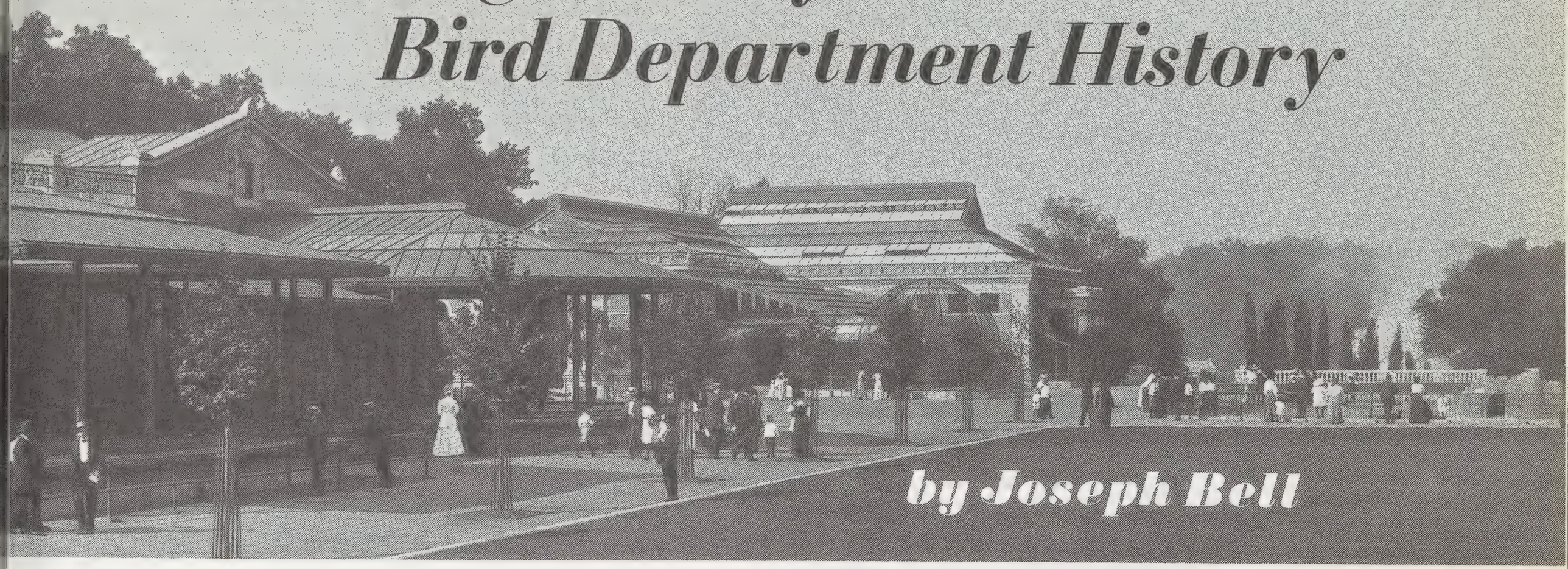
I cannot say how the penguins around me anticipated or even saw the kill. Surely, no sound came to them above the surf, and their eyes, lenses flattened for underwater use, could hardly be as sharp as mine. Yet, they perceived and reacted in concert to some cue that escaped me entirely. At the time they reminded me of a circus audience gasping in unison as a high wire artist misses his grip. They remained uneasy and alert for a long time after the sea lions had disappeared.

Leopard seals often eat penguins in the Antarctic and there are records of predation by other kinds of pinnipeds as well. But it was not until I returned to New York and began a check of the literature that I discovered that my observations may be a first for the Patagonian sea lion.

Meanwhile, in Argentina, it had grown late, and another young penguin walked up to peck curiously at my shoe. I put away my notebook, packed the camera, and folded the tripod to head back to camp and eventually to New York. When I stood up, the penguin waddled away uncertainly and plunged into the sea. If it survives, it will be at Punta Tombo next year.

Albinism is common among the penguins at Tombo. Here a partially albinized parent guards two chicks.

Some Fragments of Bird Department History



by Joseph Bell

At the turn of the century, the Bronx Zoo's Baird Court looked much as it still does today. The Large Bird House (center) was completed in 1905, and the Lion House (left) in 1903.

ARRIVALS . . . 1 male Bittern in splendid plumage, gift of William F. Doughty, New York and Boston Dyewood Company. The bird was caught in the city.

DEATHS OR ILLNESS WORTHY OF NOTE:
The Ptarmigan which had its head injured has lost a good-sized piece of skin so the wound cannot be sewed up. It appears to be doing well, after being treated with antiseptics.

GENERAL OBSERVATIONS:
No deaths among birds.

These items, taken from a Bird Department Daily Report and listing the events of note for one day, are fairly typical for that type of work record sheet. Much more interesting than the contents of the document quoted above is its date, November 4, 1904, and the neat signature in the lower right hand corner by C. William Beebe, the New York Zoological Park's first curator of birds. Nearly 200 of these unique records, all for individual days during 1904 and 1905, were brought to light by Miss Grace Davall, Assistant Curator of Mammals and Birds (and chief record keeper for the zoo's animal departments), when she retired in October 1970, after 47 years of service.

Of course, the general history of the Bird Department, now called the Department of Ornithology, is well covered in the annual reports of the society. Even so, the contents of these few daily work sheets add a personal dimension to the more formal record. The every-day problems experienced then were very much like the ones that must be dealt with today. A case in point can be illustrated by an item under "General Observations" in the Daily Report for October 10, 1904, when Beebe noted: "Two Emus were captured after a difficult struggle and installed in their permanent quarters in the new Ostrich House." It takes real imagination now to think of the Ostrich House as a new installation (it was opened to the public on December 25, 1904), but restraining and moving an emu involves the same "difficult struggle" today that it did then.

This large flightless bird, a native of Australia, is docile and even friendly under normal conditions. Adapted for a terrestrial existence, the emu has long, extremely powerful legs, a slim body, and small underdeveloped wings. Under pressure, the emu becomes a combination tornado and eggbeater. Moving a small flock in 1970 exhausted 10 bird keepers, 2 curators, and a veterinarian and involved several days of continuous effort.

The similarities between then and now go far beyond this, for the park was in the process of building in those days just as it is in the process of rebuilding now. By 1904, the Aquatic Bird House, the zoo's first building, was a well-established exhibit; the Ostrich House was newly completed;

The old Aquatic Bird House opened on November 8, 1899, in a dedication ceremony for the whole zoological park. The new Aquatic Birds Building replaced this structure in 1964.

construction of the Pheasant Aviary was underway; and the great new Large Bird House was nearing completion.

In the society's Ninth Annual Report (1904), William T. Hornaday, director of the zoo from 1896 to 1926, said, "The completion of the Large Bird House by June 1, 1905, will add to the Park a bird collection of great importance." The fact that the actual opening of this new building on July 4, 1905, was just one month later than the projected date of completion seems a miracle by today's standards.

A report written now, after a period of more than 65 years, might sound very much the same, for the new Aquatic Birds Building, opened in 1964, is an established exhibit; the old Pheasant Aviary was completely refurbished in 1968; and the new World of Birds, a modern setting for the types of birds now exhibited in the Large Bird House, is in the final stages of preparation.

An additional and interesting similarity, quite outside the realm of Bird Department history, involves totem poles. In 1904, Director William T. Hornaday was very pleased to announce the erection of "the very fine totem pole and house originally constructed by the Tlinket Indians as Cape Fox, Alaska." This totem pole and lodge, situated at the north end of the Wildfowl Pond (then called the Small Mammal Pond), was a famous zoo landmark until 1942, when it was dismantled and donated to the Museum of the American Indian-Heye Foundation. In 1970, another authentic totem pole, which had graced the St. Louis World's Fair in 1904, was mounted on a grassy plot just south of the new Big Bears Exhibit to serve as an introductory motif for the North American section of the zoo's planned Holarctic Region complex.

The zoo's bird collection in 1904 was not very large; the Ninth Annual Report lists 14 orders, 165 species, and 643 specimens. With the opening of the great new Large Bird House in 1905, the count at the year's end jumped to 26 orders, 355 species, and 1,555 specimens. This total is really not far away from the "year's end" count of 1970: 25 orders, 476 forms (species and subspecies), and 1,917 specimens. The projected opening of the new World of Birds will, no doubt, reflect another great surge in collection numbers, but the modern philosophy of keeping fewer species with more individuals of each variety will show a vastly different species-to-specimen ratio.

The zoological park has always been a haven for native birds. In the spring of 1904, Curator Beebe and a friend named Dr. Wiegman surveyed the zoo's 270 acres (boundary changes over the years have reduced the area to 252 acres) and reported in a *New York Tribune* article that 62 species of wild birds nested here.

One of their more interesting finds was a male Lawrence's warbler and a female blue-winged warbler tending a nest with six chicks. It would have been most interesting to follow the development of these nestlings to full maturity, for Lawrence's warbler itself is a rather unusual hybrid variation of the blue-winged warbler, *Vermivora pinus,* and the golden-winged warbler, *V. chrysoptera.* Beebe also noted that this was the first recorded breeding for Lawrence's warbler.

Another notable and prophetic commentary about wild birds nesting on the zoo grounds was made by Director William T. Hornaday in the *Zoological Society Bulletin* (renamed *Animal Kingdom* in 1942) for October 1903: "English Starlings are increasing in the Park at a rapid rate. Early in the morning they may be seen in great numbers perching on the fences in flocks which rival in size those of the English Sparrow and it is the opinion of Mr. Beebe that they will ultimately become as great a nuisance as that bird."

Some 80 starlings, *Sturmus vulgaris,* were liberated in Manhattan's Central Park in 1890, and several pairs were reported breeding there the following year. The starling "population explosion" and rapid extension of range to include most of North America is now a matter of history.

The bird keeping problems are very much the same for both the early 1900s and the 1970s. Space was, and still is, a major consideration. William T. Hornaday's annual report of the director for 1904 attests to this fact: "The completion of the Ostrich House and its opening on December 25, afforded

great relief to the Bird Department. Several weeks before the building was completed, it was filled by its legitimate occupants of the order Ratitae—ostriches, emus, rheas, and cassowaries—and a miscellaneous assortment of large land birds which have been crowded out of the Aquatic Bird House, and sorely needed comfortable shelter."

Under "Illness Worthy of Note," November 11, 1904, Curator Beebe comments: "The blanket was sewed on the featherless ostrich early this morning." Almost anyone who has attempted to keep these huge ratites has experienced similar problems. In small quarters, ostriches have a tendency to pluck the feathers from their own, or their cagemate's, backs. Sewing a blanket on the bird seems a novel but effective remedy for this type of exposure. A step further might have produced custom-made feather pieces for ostriches.

A note on the report for the preceding day is even more intriguing: "The ostrich with the nervous trouble was given a good dose of ammonia and brandy." Unfortunately, the only other reference to this treatment was a comment two days later reporting a decided improvement in this bird. One might suspect the effects of the powerful ammonia-brandy cocktail were very long lasting indeed.

Another reference to the treatment of a ratite is cause for real amazement. Beebe's "General Observation" for January 9, 1905, reads: "Washed the feathers and legs of the new cassowary. It is necessary to place this bird three cages away from our old female to prevent their fighting through the wires."

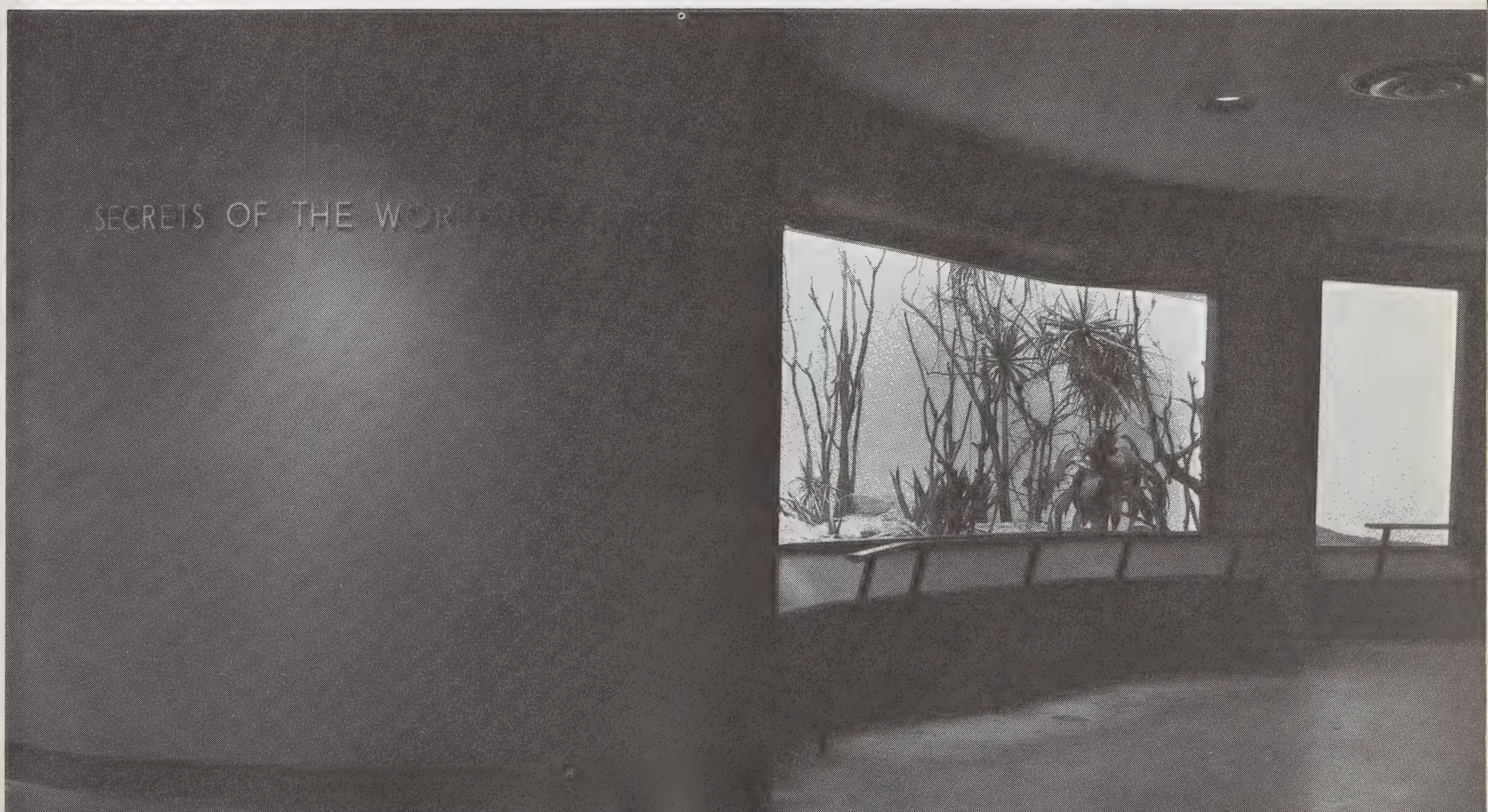
Even the largest cassowaries are not near an ostrich in size, but these wiry birds with hairlike feathers and huge feet must be rated among the most truculent creatures in the bird world, able to kill an adversary with a single kick. The 1905 keepers sound like real he-men.

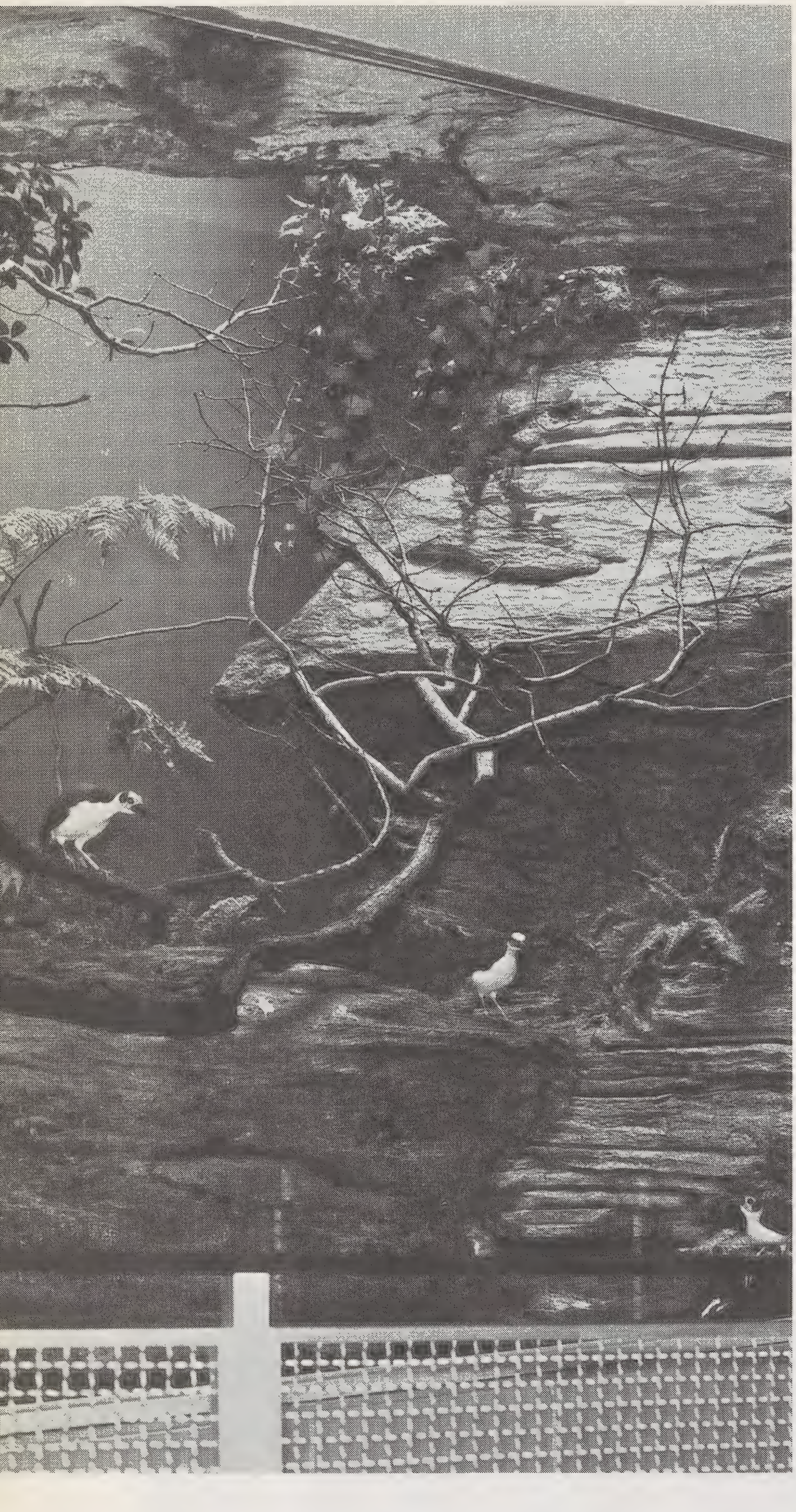
Predators in the form of feral cats, raccoons, and opossums have always posed a serious threat to the bird collection, particularly to those specimens kept in outside enclosures. Beebe's daily reports are heavily sprinkled with notes on their depredations. One of the most serious incidents of this type in 1904 involved the mass killing of 22 laughing gulls in a single night by "two or more minks."

The problem is still a serious one, but certainly not to the extent reported in the *Zoological Society Bulletin* of January 1916. In this issue Dr. Raymond L. Ditmars says, in part: "Few city dwellers realize the evils resulting from the neglect of cats that are kept for a time as pets, then allowed to wander . . . It has been necessary to detail one of our men to trap neglected felines that have taken to a life in the woods and subsist largely upon birds, young rabbits, and squirrels."

Ditmars reported that for a three-year period, ending November 1915, 602 cats had been trapped on the zoological park's grounds. During the same

The sign reads "Secrets of the World of Birds," and this is but one of several themes that the 28 exhibits will explore in the Lila Acheson Wallace World of Birds, which will open to the public during 1972.





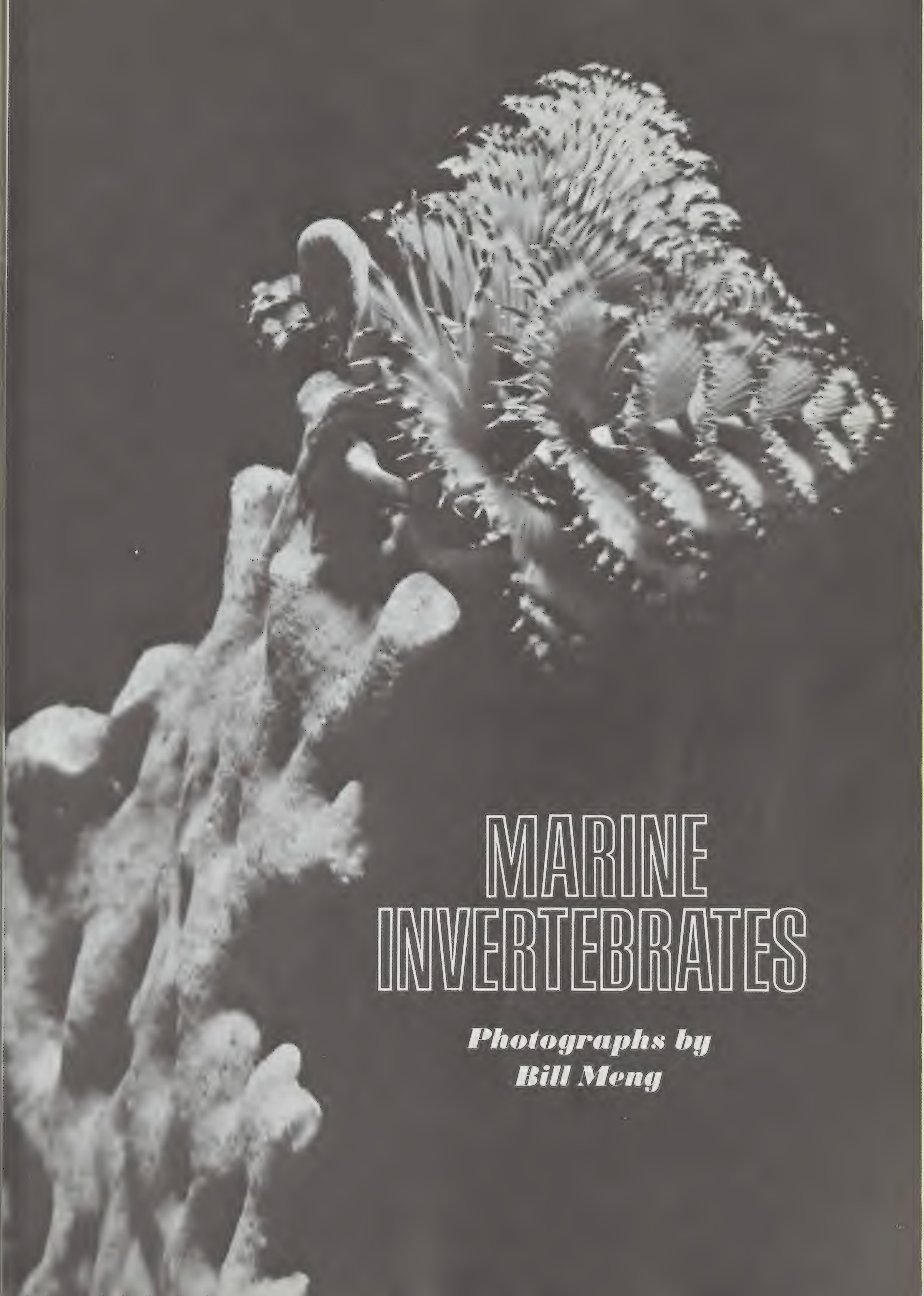
All of the exhibits in the Aquatic Birds Building and the World of Birds are either open-fronted or glass-enclosed. The birds, as with these picathartes in the Aquatic Birds Building, are literally right before your eyes, without the visual and psychological barriers of bars and wire mesh.

period, 25 raccoons, 21 opossums, and about one dozen weasels were also trapped. The fact that any of the birds in outside enclosures survived is surprising.

One of the keepers' nightmares is a recurrent dream featuring the escape of some, or all, of their charges. It does happen; and often the birds return of their own accord, but not always. In early December 1904, there were two escapes. On the first occasion, two Canada jays, *Perisoreus canadensis,* escaped when their cage door was broken open by "some unknown" person; one bird was recovered nearby. The second instance was far more serious. Beebe's terse notation under "General Observations," December 6, 1904, reads: "Stacy allowed a cageful of birds to escape. He has been transferred to the Ostrich House and the Pheasants." Disgrace, banishment and exile! Every experienced keeper has had some setback in his career that seemed as dire as this.

The redoubtable Samuel Stacy was born on the estate of the Duke of Wellington in Hampshire, England. He was well liked by the Duchess who put him in charge of her collection of birds and later secured a position for him at Regent's Park Zoo in London. After working there for several years, he came to the New York Zoological Park. It may seem rather unkind to retell this story about the legendary Samuel Stacy's early misadventures here, but his long service as head keeper of birds (he retired in 1941) and his reputation as a knowledgeable aviculturist can certainly withstand any historical comment.

Reading zoological park reports is a rewarding pursuit, but sometimes just a little unsettling. Comparison between then and now is not always the most favorable for the latter period. There are many questions that one would like to pose to William Beebe, Samuel Stacy, or any other department member of that period. Unfortunately, not a single one survives today, and we must be content with the official written record; some few treasured, first-hand accounts (like the Beebe Daily Reports); and a few legends.

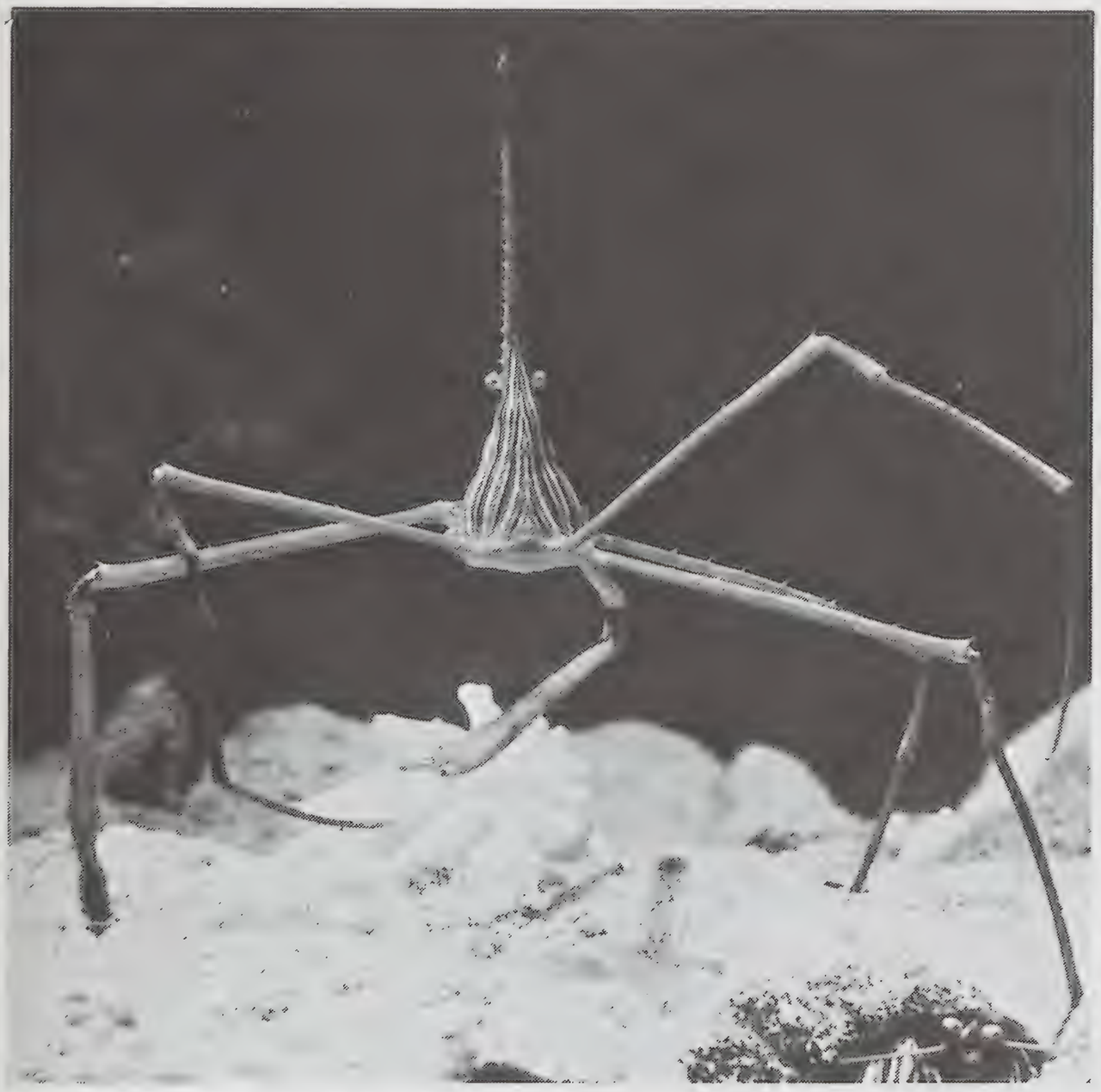


MARINE INVERTEBRATES

Photographs by Bill Meng

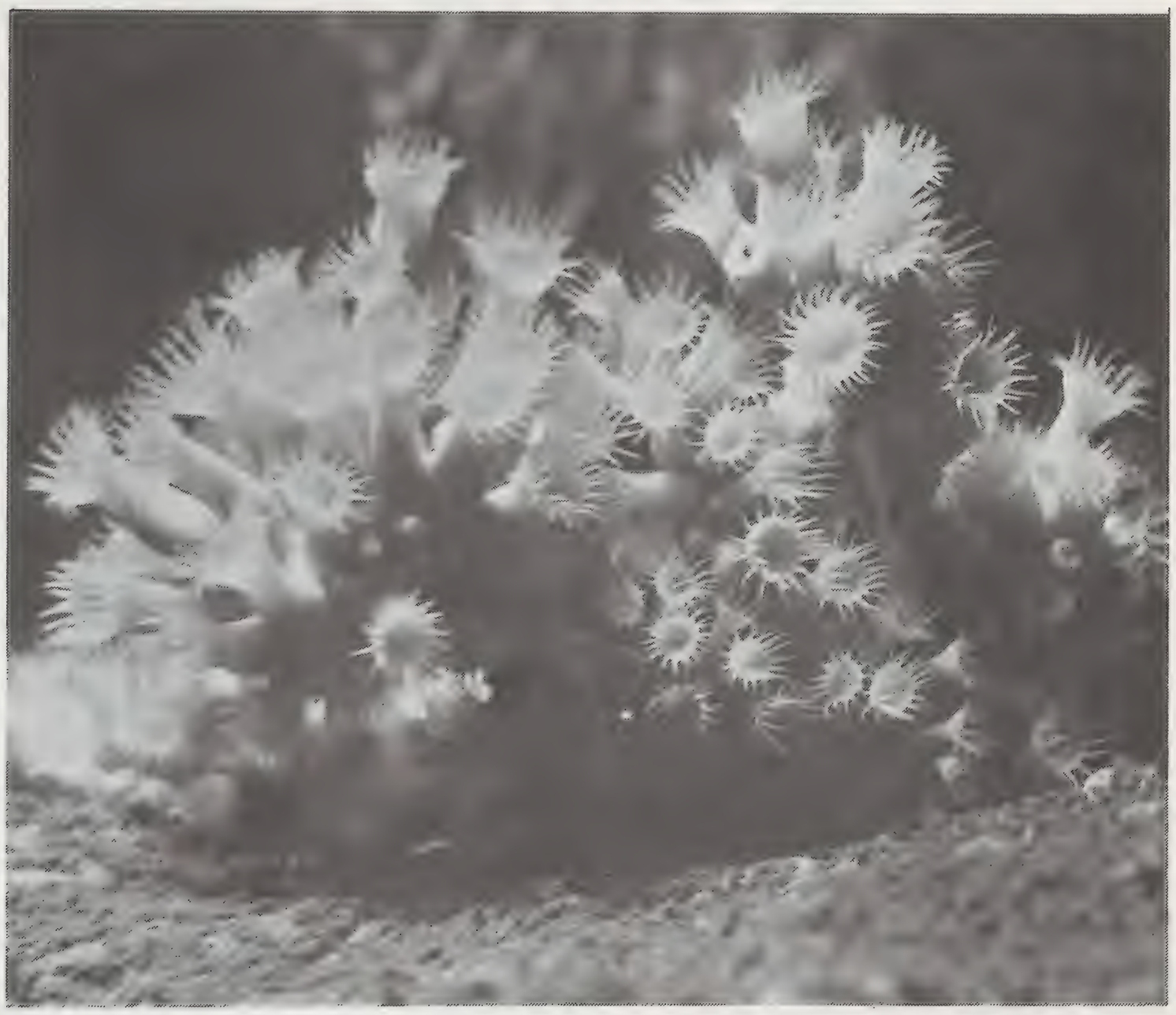
OPPOSITE, TOP: HERMIT CRAB
OPPOSITE, BOTTOM: CORAL POLYPS
SHOWN ON PAGE 15: FEATHER-DUSTER WORM

BELOW, TOP LEFT: ARROW CRAB
BELOW, BOTTOM LEFT: SEA ANEMONE
BELOW, TOP RIGHT: POWDERPUFF ANEMONE
BELOW, BOTTOM RIGHT: FEATHER-DUSTER WORM



BELOW: AMERICAN TUBE ANEMONE, OR *CERIANTHUS*

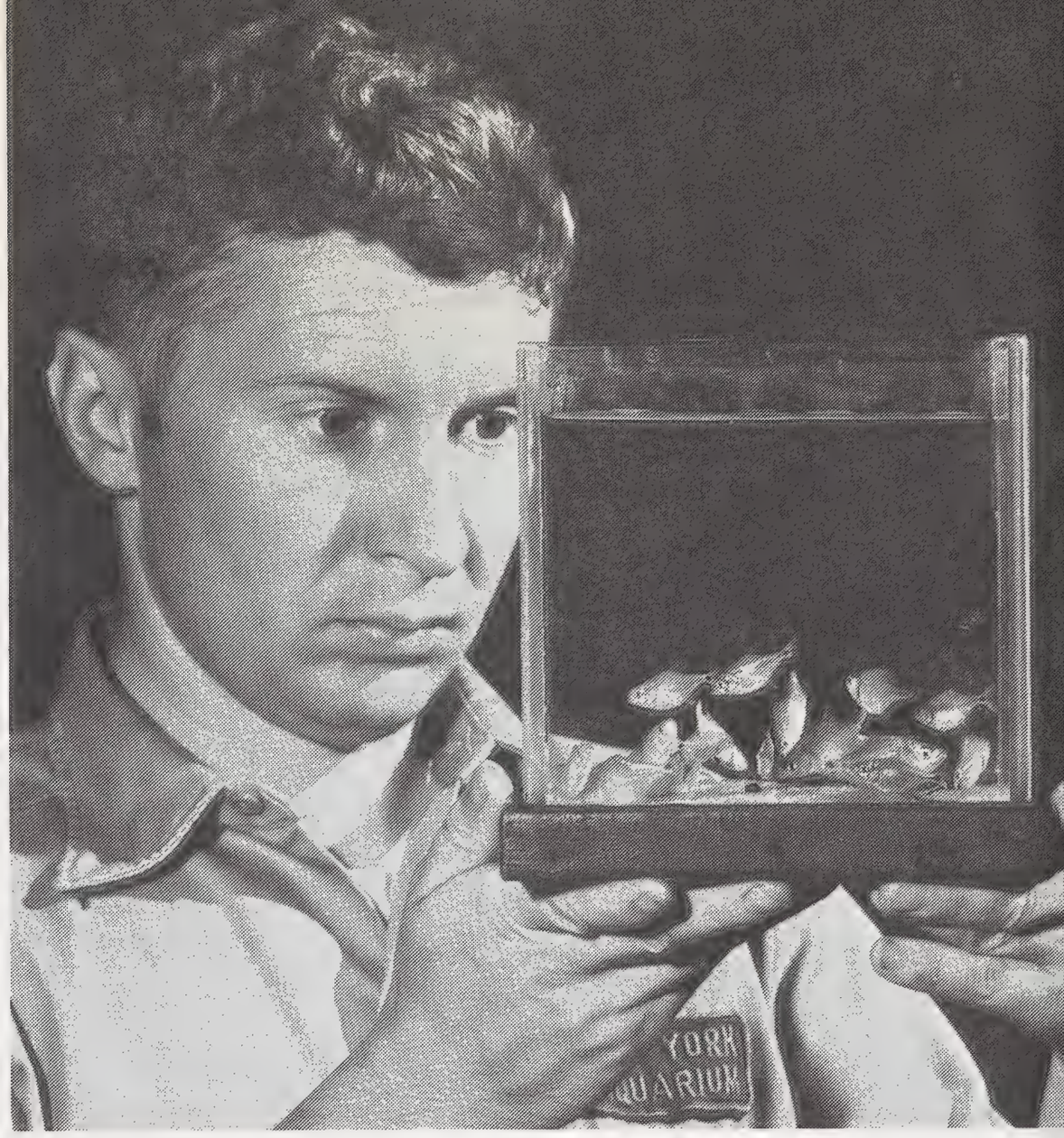
BELOW: CORAL POLYPS



ABOVE: HERMIT CRAB

PIRANHA

by H. Douglas Kemper and Werner Schreiner



Keeper Werner Schreiner of the New York Aquarium bred the black piranha, *Serrasalmus rhombeus,* for the first time in captivity. At right, Mr. Schreiner holds a tankful of the offspring from that first breeding.

With the possible exception of the shark, few fish have such a gory reputation as the piranha, alleged scourge of the rivers of half of South America.

The piranha has been characterized as a blood-thirsty demon, a raging predator of the waterways that, in numbers, turns living creatures to skeletons in seconds. Unquestionably some species are dangerous to beast and probably to man, but the piranha is not the devil its reputation makes it out to be.

Even so, however, the piranha is well-named. Piranhas acquire their name from words of one of the South American dialects, "pira" meaning fish and "ranha" meaning tooth. The large triangular teeth of this fish, driven by powerful jaw muscles, can cleanly sever the flesh of prey as neatly as a razor. South American women have been observed using the dried jawbone of the piranha, with teeth in place, like scissors to cut thread at their looms.

Piranhas belong to the family of fish called the Characidae, or characins, which include many popular home aquarium favorites, such as the neon tetra. The characins are a large group of freshwater fishes of diversified habits and form that are found mainly in tropical and sub-tropical South America. A few isolated genera live in Africa, and in the Americas some species range as far north as south Texas. The true piranhas, however, are found only in South America.

Piranhas may be seen individually, in small groups, or in schools of several hundred or more fish. Certain species seem more prone to gather in large masses than others.

There are several species of piranha and they occur throughout most of tropical South America. Many of these species could possibly present a potential hazard, but only four seem particularly dangerous.

These are all of the same genus, *Serrasalmus;* they are *S. nattereri, S. spilopleura, S. niger,* and *S. rhombeus. Serrasalmus nattereri* is probably the species most responsible for the piranha's fearsome reputation. Positive identification of the species responsible for reported attacks tends to be very difficult, as the ranges of several species overlap one another.

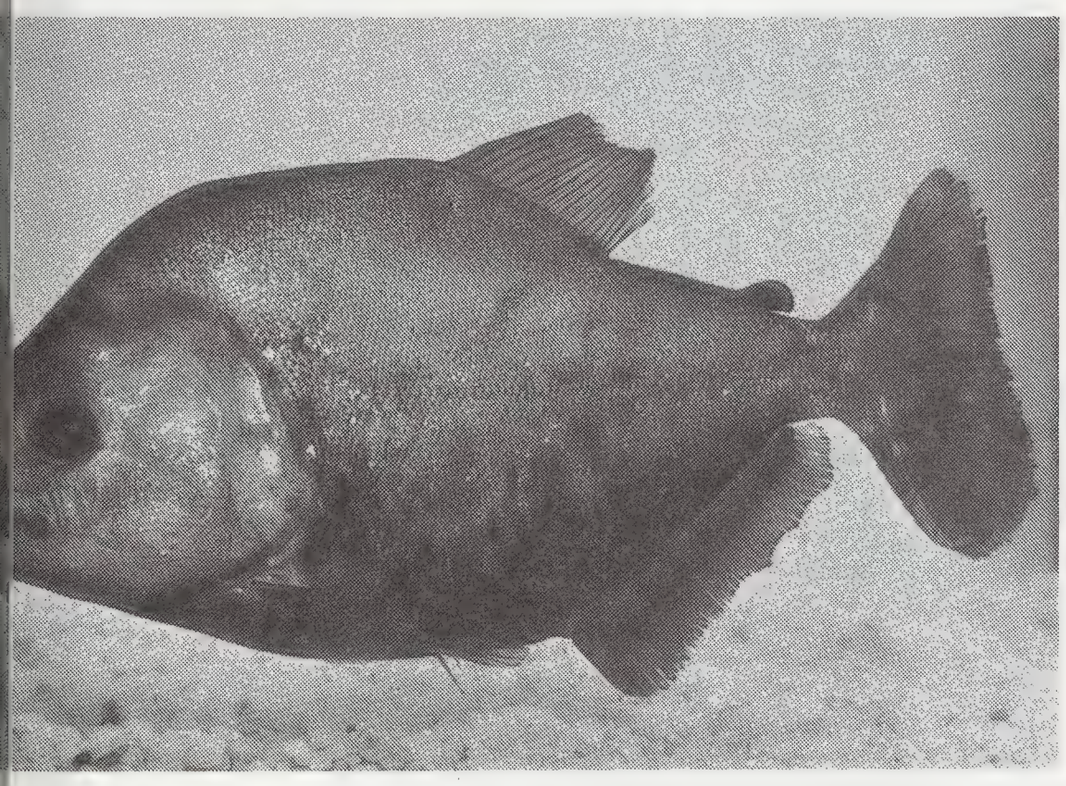
The largest piranha seems to be *S. niger,* which grows to a length of 18 inches and a weight of about 5 pounds. *S. nattereri* and *S. rhombeus* grow to be about a foot in length, while *S. spilopleura* is the smallest at about nine inches long.

The piranha is commonly used as a food fish and is savored by people of the areas in which they live. One American visitor to piranha country described the flesh of the piranha "as good as broiled bass." The fish are taken by nets, hooks, spears, clubs, and a number of other methods. The fish usually are roasted over an open fire immediately after being caught.

Even though the piranha is considered to be a highly dangerous fish throughout most of its range, there has yet to be an unquestionable report of piranhas having killed a human. This is not to say that an incident of this nature is impossible because the piranha, especially in large schools, is certainly capable of inflicting severe injury or death to a person. However, so far none of the tales of human deaths caused by piranhas have ever been authentically documented.

Piranhas have attacked Amazon River fishermen and bitten out chunks of flesh the size of a silver dollar, but these men show little fear of the creature. The freshwater sting ray, *Potamotrygon histrix,* with its painfully venomous sting and resultant possibility of infection, is of much more concern to native fishermen and bathers than the piranha.

Until recently, numbers of piranha were imported into the United States and sold to home aquarists at a comparatively high price. Because of the fear they might become established in the waterways of this country, legal restrictions have been placed on the importation and sale of these fish. New York is one of the states which requires a permit to keep live piranhas in a home or public aquarium.



The fearsome reputation of the piranha is based not on its size — the largest of the four species considered particularly dangerous is less than two feet long — but on its short, sharp teeth in the jutting jaws and its habit of attacking in swarms.

The black piranha is widely distributed throughout the northeastern part of South America and the Amazon River Basin, as far west as middle Brazil. It grows to 12 inches in length. Its name describes its predominant hue. In the wild the food of the black piranha consists mostly of fish and other aquatic animals.

Last year the first known spawning of the black piranha, *S. rhombeus,* in captivity took place at the New York Aquarium. On June 5, 1970, the pre-spawning, or courtship behavior, was noted in the exhibit tank, where a pair of black piranha have been exhibited with two other species of piranha in a 1500-gallon aquarium in the main exhibit hall. During mating, the male and female fish swam side by side, quivering their fins and bodies.

The actual spawning occurred from 5:00 P.M. to 8:00 P.M., at which time the two fish swam over a small area in the front corner of the aquarium, releasing and fertilizing the eggs at the same time. The eggs were delivered in batches of 25 to 50, approximately two to five minutes apart. At 7:30 P.M., near the end of the spawning, the time period between the releasing of eggs increased to ten minutes, when as few as two to five eggs were released. The male parent, which could be discerned from the female by lighter pigmentation and slimmer body shape, guarded the eggs from other tank inhabitants.

On four occasions eggs were removed from the spawning site and placed into a 20-gallon, all-glass, aquarium in the tank room.

Eggs hatched within two to three days, and the yolk sac appeared to be completely absorbed by the ninth day after hatching. By the tenth day, the young fish were able to swim about when disturbed, but most, after darting about, settled to the bottom. Eleven days after hatching, the young fish ate young brine shrimp. At this stage, the fish remained at the bottom, but swam about frequently. When the fish were fourteen days old, they began to aggregate quietly at the surface, barely moving about. One month later the young piranhas were feeding on shrimp eggs, live daphnia, and tubifex worms, and were chasing after the food with vigor.

The aquarium hopes to hatch more young piranhas during 1971, but space may prove to be a problem. Piranhas seem to be very spatially oriented and territorial, except during feeding time, and it is quite interesting to see the group of young spaced about four inches to six inches apart in the tank, as if each were suspended from an invisible wire. The fish will not tolerate a tank mate that gets too close and will readily chase away the intruder.

Piranhas are cannibalistic (hooked specimens in the wild have been mutilated by their schooling mates before they could be landed), and if the tank should become too crowded with additional hatchlings, the fish might devour one another if the space tolerance could not be maintained.

A number of the young piranhas have been shipped to other aquariums around the world, but about 100 of the now two-inch-long young fish can still be seen on exhibit with their parents at the New York Aquarium.

The Reptiles of Paha Sapa

by G. Earl Chace

The author is curator of the Black Hills Reptile Gardens in Rapid City, South Dakota, a city close to the hills and its accompanying ledges with snake dens. While this is an enviable position for a herpetologist, many of Mr. Chace's neighbors do not share his enthusiasm.

About 60 million years ago, an intrusion of granite lifted the mountains now known as the Black Hills of South Dakota. An ancient sea had left a heavy deposit of sedimentary rock and the intrusion pierced this layer at various points, forming spires and pinnacles, yet leaving huge limestone plateaus and cliffs. Erosion gave the Hills fertile valleys, level meadows, and drainage streams. Today we have a rocky, foliage-covered island surrounded by a sea of prairie that stretches for hundreds of miles in all directions.

The Hills form an oval 100 miles north-south by 50 miles east-west. The surrounding prairie averages 3,000 feet in elevation and the tallest mountain, Harney Peak, reaches an altitude of 7,240 feet. The Black Hills are located in the southwestern corner of South Dakota, an area with an annual rainfall of only 14.7 inches and a very low average humidity. Winter temperatures can drop to 25 degrees-below-zero and summer heat can soar to 105 degrees, a difference of 130 degrees.

Its isolation in the plains produces a static fauna population, generally incapable of fast locomotion or instinctive prairie existence. All forms of life face a combination of altitude, latitude, temperature extremes, low humidity and rainfall, deep frost, warm days and cool nights, summer hail, early falls and late springs. This is just not conducive to most reptiles.

The Hills are high enough to be visible for about 40 miles, yet low enough to enable the dominant ponderosa pine to grow to the summits. It is the soft outline and deep color of these pines that suggested the name to the Sioux, Paha Sapa, or the Black Hills.

Although the Hills are well supplied with both large and small mammals, a fine collection of birds, and fish, the slower, more climate-dependent reptile has suffered. Only 14 species are included

in this resume of Black Hills' reptiles. Other species are suspected of being present, but after 20 years without success in finding them, I conclude that if they are present, they are exceedingly rare.*

Only 10 species of snakes seem to be indigenous to the area and the first of these is so small, secretive, and innocuous that usually only small boys who like to turn logs and stones ever find one. It is called the Black Hills red-bellied snake *(Storeria occipitomaculata pahasapae).*

Full-grown this snake is but 10 inches long, and it is smaller in diameter than a lead pencil. It is found only under logs or rocks, exclusively in areas of moisture, such as around beaver dams and ponds. Its food consists of earthworms, slugs, and occasional insects. It is so delicate that one wonders how it survives the long rigorous winters and deep snows that visit the valley habitats.

Along with the red-bellied snake, one might also find another small Hills reptile, the smooth green snake *(Opheodrys vernalis).* The habits and habitat of this snake are similar to the red-bellied, but it is a bit larger, 15 inches or more in length, and it has a much greater range and is found more frequently.

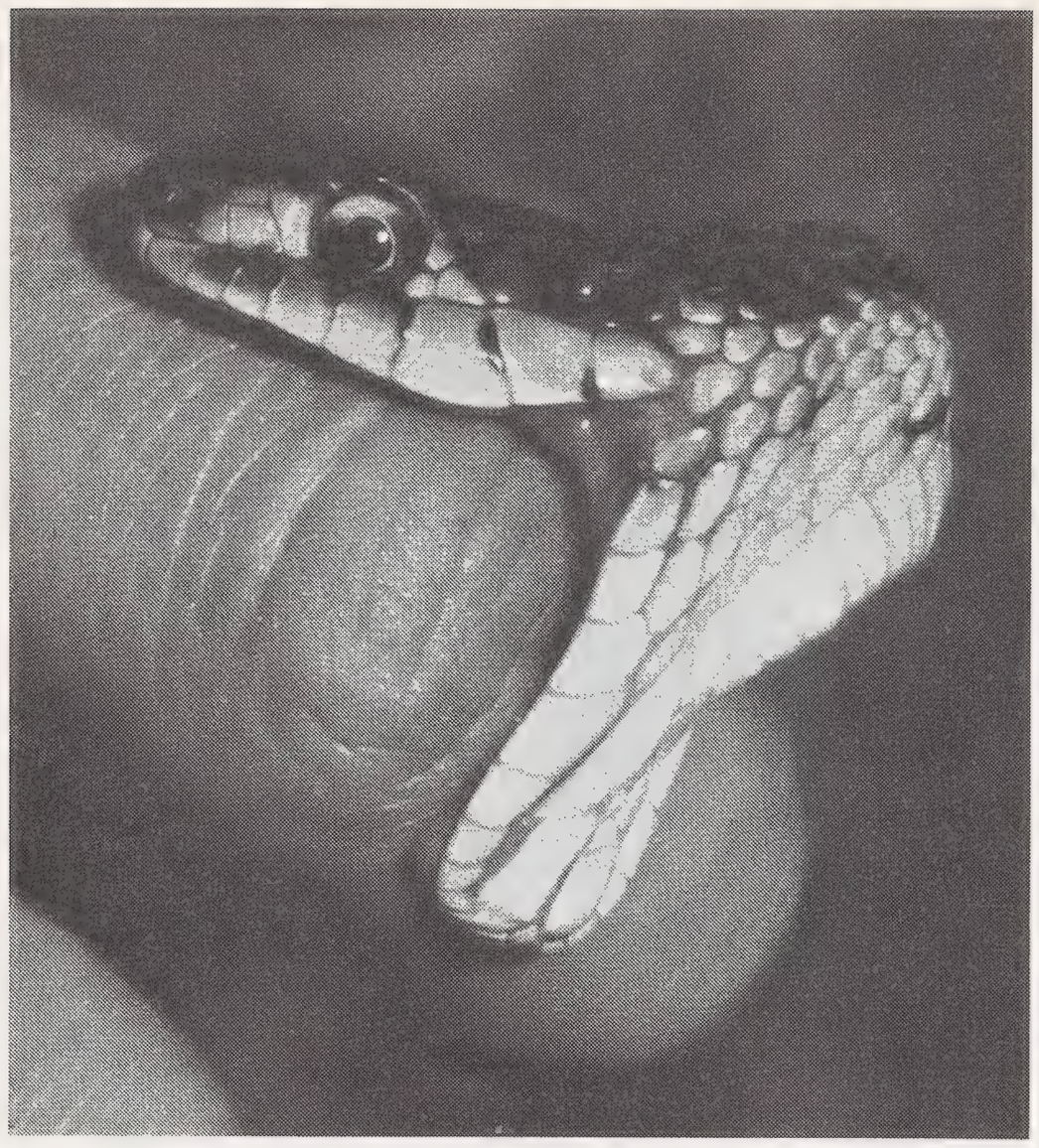
Green snakes will leave the dams and ponds to follow the brooks and streams through comparatively dry areas. They too eat earthworms and insects. Both specimens are exceedingly popular with the Boy Scouts who are working on reptile study merit badges as either will fit in a small terrarium and eat easily obtained earthworms. Their small size and gentleness also soothes the anxious mothers of young reptile fanciers.

The western milk snake *(Lampropelitis triangu-*

* Dr. Hobart M. Smith of Boulder, Colorado, has reason to believe the Hills fauna also includes a fence lizard and a ribbon snake.

A Herpetologist's Report from the Black Hills of South Dakota

The western milk snake, also known as the king snake, is rarely found in the Black Hills today; its beautiful markings of black, red, and pale yellow too closely resemble those of the poisonous coral snake, and this harmless snake is usually killed on sight.



The plains garter snake, although normally a gentle creature, will on occasion defend itself vigorously. In the incident pictured above, the bite caused no serious damage other than alienating the affections of the author's daughter who owned the finger.

lum gentilis) may be found most anywhere but seldom is. Unfortunately, the colors and markings of this snake too closely resemble those of the poisonous coral snake. The harmless milk snake is usually killed on sight. Only two or three specimens reach the Black Hills Reptile Gardens alive during the year, and perhaps as many more arrive chopped to bits and enclosed in a wire-bound can for identification.

The young milk snake is the most vulnerable; its black, rèd, and pale yellow markings are brilliant and stand out vividly against the grass. By the time it has attained 15 inches, the snake's colors begin to fade, and the 20-inch adult has a comparatively washed-out appearance. It is a truly eventful day when a herpetologist finds a wild, live, healthy western milk snake for his very own. I found one once, surrounded by a hand-holding line of mothers who had called for help. Even on the spot, backed up by a live specimen and an illustrated handbook of American snakes, I could not convince them it was not poisonous.

The eastern yellow-bellied racer *(Coluber constrictor flaviventris)* is a bluish slate color on its back and yellowish green on the belly. Although perfectly willing to bite if you pick one up, they seem to prefer to race away. A penchant for fighting back often costs the young ones their lives. Newborn racers are banded and do not resemble the adults in color or pattern. The plucky little fellows will rear back and strike, and are often destroyed because "anyone knows a striking snake is poisonous."

Racers do not grow very large in the Hills area; three or four foot specimens are big. They are quite prolific, however, and lay 12 or more eggs in local leaf or manure piles where the moist rotting material provides protection, heat, and moisture until they hatch.

There are three species of garter snakes in the Black Hills area. One, the plains garter snake *(Thamnophis radix),* is found everywhere and often in quantity. Garter snakes are live-bearers and their brood of 14 or more babies can be dropped anywhere. The seven-inch babies resemble mother in all but size, and they immediately spread out in all directions catching whatever worms, insects, frogs, or even small fish that their agility and luck may bring.

The plains garter snakes are not as aquatic as most garter snakes. They can thrive way out on the prairie where only an occasional stock dam or heavy shower is available to slack their thirst. In the Hills, adequate water, food, and cover provides sustenance for about all that are born. They have no fear of civilization and make their homes in back yards or old homes, even to hibernating in cracks in basement walls. Although maximum length is sometimes recorded as three feet, under ideal captive conditions, several inches has been added to this length by specimens that have been fed mice.

The second garter snake, the red-sided *(Thamnophis sirtalis parietalis),* is not as common as the plains species, but haunts much the same areas. It received its name from the red skin that shows between its scales. Neither species is prone to bite when picked up, but some individuals do, and frankly their bite causes less anguish than their other defence, which is emptying both their bowels and their foul-smelling anal glands on the collector.

The wandering garter snake *(Thamnophis elegans vagrans)* reaches only the southern Black Hills. Although most people recognize and tolerate the garter snake, this one, because of its darker color and vague stripe, is often called a water snake. Some people call it a water moccasin and, of course, kill it. My own daughter was bitten by one at a summer church camp. Although she protested vigorously and called me, the attending nurse still managed to tourniquet and cut the area before I could come to the rescue.

The bull snake is the largest snake of the Black Hills area, reaching a length of five feet. Adults are easily recognizable and are respected as rodent-eaters.

The largest snake of the Black Hills area is the five-foot-long bull snake *(Pituophis melanoleueus sayi).* An egg layer, this powerful contrictor prowls the entire western South Dakota, eating rodents and, as most people admit, earning its keep. It dens in the same areas, and frequently in the same dens, as do the rattlesnakes. Around the Hills, there is a story that bull snakes fight and chase the rattlers away. People who believe this story tolerate and protect the snake, if for this reason alone. Of course, this is not true but we who know better whisper, rather than shout, the truth to abet this protection.

Baby bull snakes do not resemble their parents, but are banded in color and pugnacious in disposition similar to the baby yellow-bellied racers. For this reason they suffer the same fate—killed as a dangerous unknown.

Bull snakes are warmth-loving creatures, sunning themselves by day and, when the sun goes down, crawling out to warm their bellies on the heat-retaining black-topped roads that wind through the Hills. Even the best of us cannot always avoid hitting the snake as we drive round a corner and see it in our car headlights.

The little western hognose snake *(Heterodon nasicus nasicus)* is not too well known. It is not commonly found in the Black Hills proper but in the more sandy areas adjacent to the Badlands,

The Badlands of South Dakota are reminiscent of a moonscape. Only the grassy uneroded mesas of this area are useable, and even there the access routes are continually washed away. The gumbo soil prohibits any travel during or after a rainstorm other than on surfaced roads.

When confronted with danger, the western hognose snake rolls over on its back, protrudes a limp tongue from its half-opened mouth, and plays "dead."

and although not rare, neither is it abundant. Because its markings and coloration are similar to the prairie rattlers,' it is more often killed than admired.

The domain of the hognose is the dry areas where it must dig for its dinner. A turned-up nose earns the snake its name and also its fare. The nose is used to plow up the loose soil in search of toads which have been forced to dig in to escape the dry air and summer heat. The spadefoot toads that the hognose eats are remarkable. They have learned to lay fast-hatching eggs that produce fast-maturing tadpoles. By the time the spring rains are over and the pools are drying up, the tadpoles have turned into little toads and are quite capable of surviving without the puddles. Although the hognose prefers these toads, several hognose snakes kept on exhibit at the Black Hills Reptile Gardens have accepted small mice.

The hognose is no fighter; rather, it puffs itself with air, inflating its body enormously and allowing the air to escape with a loud hiss. If this maneuver fails, the ingenious little rascal rolls over on its back, protrudes a limp tongue from a half-opened mouth, and plays dead. The flaw in this game is that its one-track mind insists it must be on its back to be convincing. If pushed or pawed over to its stomach, the snake immediately rolls back.

The hognose is also one of a few snakes that gives any personal care to the eggs. The female will sometimes coil about the 10 to 14 eggs in an effort to protect them.

The prairie rattlesnake *(Crotalus viridis viridis)* is without a doubt the predominant snake of the Black Hills area, at least psychologically. It is the only species of poisonous snakes to be found for a distance of 400 or more miles in any direction.

Actually only four general types of dangerously poisonous snakes are found in the entire United States. The coral snake, copperheads, and water moccasin are found only far to the east and south of the Hills, and only three other species of rattlers even come close. About 400 miles to the east, in southern Minnesota, the range of the timber rattler begins and extends to the Atlantic Ocean. The western diamondback rattler comes as far north as extreme southern Kansas, and the Pacific rattler stays west of the Rocky Mountains. To the north, all snakes peter out in southern Canada.

Crotalus viridis viridis is essentially a prairie snake and for generations has used prairie dogs as a basic diet, and the dog holes for shelter and hibernation. Today most of the prairie dogs have been exterminated and the snakes have moved on.

Excellent living for the prairie rattlesnake is furnished by the buttes, mesas, and foothills of the mountain ranges. These rise sharply from the prairie, and the base is normally composed of fractured rock that furnishes adequate shelter and denning sites for the snakes. The water run-off provides enough moisture for the plants and grasses that in turn feed numbers of rodents. The dens are but centers of a three-mile hunting radius for the rattlers.

In the flat areas, the summer sun forces the snakes to seek shade in clumps of grasses, which may be all the shade available. As grazing cattle nuzzle such clumps, they are occasionally bitten on the nose. The amounts and toxicity of this small rattler's venom could hardly kill such a large animal, but the resulting swelling takes place so close to the windpipe that death by strangulation sometimes does occur. After a few such incidents, the farmers and ranchers asked for and received help in the form of an official state snake-eradicator.

Finding which ones of thousands of likely spots actually harbor the snakes is difficult. In areas where many snakes are seen, fresh sand is sometimes sprinkled in front of several likely dens and watched for snake tracks. Once evidence is found, traps are set in either the spring or fall. Spring

collections are heavier, but many snakes are also caught during Indian summer.

Box traps are used on level land. A wire box with a clear light-weight, hinged, plastic door over a hole in the floor works well. It is set on the ground with the plastic-covered hole right over the exit hole of the den. The snake crawls up its exit hole, pushes against the plastic door, enters the box, and is trapped as the plastic drops back in place.

Barrels are set just below dens found on a slope. A stove pipe leads from the den into the barrel through a hole in its side about two feet from the bottom. A light, transparent flap on the barrel end of the stove pipe prevents re-entry. One such barrel trap set by the Reptile Gardens personnel a few years ago yielded in one spring setting 130 rattlesnakes and a few, immediately-released, bull snakes and racers.

The Reptile Gardens buys many rattlers which would otherwise be killed on the spot. They are used both for exhibit and for hourly demonstrations of snake-striking and snake-milking. A lecture of pertinent facts is also given on the snake's habits, its danger to man, and first aid for snake bite. As a local service, the Boy Scouts, schools, and service clubs are visited continually by our personnel, who bring live snakes to acquaint everyone with them. Newspapers and television stations run our spring refresher course concerning the

The prairie rattlesnake is the only poisonous snake to be found in the Black Hills. Although not large, the rattler's average two-and-a-half foot length is more than matched by its nasty disposition.

The snapping turtle is probably the most common turtle to be found in the Black Hills. The 20-pounder pictured here could break a man's finger with its bite.

safety factors involved. Consequently, although local farmers, ranchers, and fishermen sometimes encounter snakes, bites are infrequent and, when they do occur, are usually cared for properly.

One range of hills that bisects Rapid City is honeycombed with potential dens. In the spring, a few rattlers, intermixed with bull snakes and yellow-bellied racers, issue from these dens and work their way down the slope. Home owners who have built on the slopes are not at all happy with this situation but, because of the number of potential dens and the large area involved, there is little one can do about it. Year by year, however, this urban snake population is being killed off.

Because of this thinning of the snake population, the Reptile Gardens has recently constructed a huge artificial den, complete with an outside escape-proof yard, in an attempt to breed and perpetuate the species.

Prairie rattlers are not large; two-and-one-half-feet is considered an average length. The snake is nasty and noisy, however, rattling at the slightest provocation and striking when approached. The striking range averages about two-thirds of the snake's body length. Although numerous in some sites, the snake shuns built-up areas when possible.

Both the Black Hills and the surrounding prairies, although described as semi-arid, have adequate bodies of water. Rain is spotty but torrential, and numerous small stock-dams have been built across run-off areas to store it. In the Hills, large man-made reservoirs serve the cities and towns, and beavers have constructed many dams on the drainage streams. Other dams erected primarily for flood control also create bodies of standing water. All of the small streams draining these reservoirs end up in one or two large rivers such as the Cheyenne, which, although normally shallow, muddy, and slow-moving, swells considerably during floods or spring run-off.

It is in these bodies of water that our three types of turtles are found, the common snapping turtle *(Chelydra serpentina),* the western painted turtle *(Chrysemys picta belli),* and the spiny soft shell *(Trionyx spiniferus).* Of these, the snapping turtle is by far the most common.

Snapping turtles start life from eggs that resemble white ping pong balls which are deposited in holes dug in the ground. As they hatch, the little turtles scramble from the holes *en masse* and instinctively head for water.

From here on the turtle is interested in but one thing—food. It eats anything it can conquer and as it matures, the food list becomes endless. In the water, it grubs crustaceans, worms, and insects from the bottom, catches fish at mid-depth, and picks birds off the surface. Snappers are destructive gluttons.

Although snappers possess no teeth, the hard bony ridges, the stout muscles, a very fast strike, and a tenacious hold make the bite of a large 20-pound to 30-pound specimen a matter of concern. There is a story in the area that snappers will hold on until it thunders. Believers are particularly careful around snappers in this semi-arid district.

The western painted turtle chooses a large pond, lake, or beaver dam for its domain. These turtles seem content to just laze around, swimming idly or sunning themselves on logs and rocks. Their greatest activity is to slide into the water to seek food or to avoid capture.

Painted turtles eat either plant or animal material. They are more deliberate than the snapper and seem incapable of catching fast fish, but grub along the rocky bottoms for crustaceans and insects, and sample the abundant plant life. Their gentle dispositions and colorful shells make them a prime target for pet seekers.

The spiny soft shell is purely aquatic and often goes by the name of pancake turtle simply because it resembles a web-footed pancake. It is a fast swimmer, a bottom-lover, and is usually seen only as a departing streak of roiled mud as it heads for deep water and sanctuary. Its disposition resembles that of the snapper—mean and fast. The turtle is usually brought to the surface only by fishermen, who have an interesting few minutes attempting to remove the hook, avoid a bite, and at the same time hang on to a soft, wet, squirmy, slimy "flapjack."

Soft shells are not often seen sunning themselves, but merely rise close to the surface and reach up with their long necks, sticking a snorkle-like nose out of the water to get a new lungful of air. They are found not only in the lakes and ponds but also in the lazy, shallow, muddy water of some of the wide, permanent drainage rivers.

The painted turtle is the most abundant and widespread turtle in the northern United States. Marked with narrow red bands on the legs and yellow lines on head and neck, it is eagerly sought by collectors.

The eastern short horned toad is the only species of lizards normally found in the Black Hills. Shown at left is a mother with four young.

Somehow the lizards were all but left out when the Hills were populated. One little horned lizard was included. The eastern short horned lizard *(Phrynosoma douglassi brevirostre)* is found only at either extremity of the Hills, and both areas are adjacent to old reservoirs. The lizard is unique in that it bears 20 or more dime-sized young alive, rather than by laying eggs. Full-grown lizards are silvery in color, about the size of silver dollars. At birth they usually eat ants, but as they grow they can eat larger and larger insects.

When picked up, the harmless horned lizard uses its normal defence, that of inflating itself with air. Its increased size and spines may cause a collector to drop it or prevent a predator from swallowing it. The ultimate weapon for this little lizard is to create sufficient pressure to burst one of the blood vessels around the eye. The surprise created by this action might just save the lizard on some occasions.

The Badlands, east of the Black Hills, are a tremendous area of extreme erosion. As the name implies, the land is bad. It is arid, hot, barren, and except for a few grass-covered plateaus, good for little more than its fossils and its picturesque views. An occasional bull snake or rattlesnake can be found atop the larger plateaus where cattle graze; otherwise, the Badlands are left to the eagle, vulture, coyote, rabbit, tourist, and fossil hunter.

A visit to the Black Hills and neighboring areas is a rewarding experience for everyone, except perhaps the herpetologist, and the paucity of reptile species is undoubtedly his only complaint. Apparently those things which produce a reptile haven—an even warm temperature, high humidity, and an abundance of insects—are just not present. Nevertheless, some reptile forms can be found in the Black Hills, and the lack of ideal reptile climatic conditions mentioned above may be considered a gain for us humans of Paha Sapa.

animal kingdom REPORTS

BRONX ZOO HAS A HOME WHERE THE "BUFFALO" ROAM

A herd of 11 shaggy American bison was loosed on a newly-created "prairie" at the Bronx Zoo, July 20, as the zoo opened its new American bison range.

The three-acre exhibit was reclaimed from the zoo's Lake Agassiz. An earth berm supporting a low fence borders the range on three sides. The new bison range also has a concealed shelter, including a feed barn and holding pens for the animals. The herd at the zoo consists of six adults, four calves, and one yearling bison. Visitors will be able to view the bison from two overlooks near the range.

The bison is sometimes called a "buffalo" but the name is incorrect. When colonizing this country, English settlers called the bison "buffle" and "buffelo," which the colonists later adapted to "buffalo." This name has remained with us and has become firmly established as a name for the American bison.

The American bison is the largest of North American hoofed animals. It is a herbivorous animal and can live for as long as 22 years. Its weight varies from 1300 to 2300 pounds, and a male may stand 5 feet 9 inches at the shoulder.

At one time about 60 million bison swarmed over the prairies. But in the late 1800s, as railroad construction went deeper into bison country, these animals were savagely slaughtered for their hides, meat, and often just for sport. By 1895 only a few hundred wild bison remained alive.

In 1905 the New York Zoological Society sponsored the development of the American Bison Society which worked for legislation to preserve the American bison and establish refuges for it. Meanwhile the Bronx Zoo had been breeding bison in numbers, and by 1907 had enough bison for the New York Zoological Society to supply a nucleus herd of 15 animals for the government's Wichita Bison Reserve in Oklahoma. Later the zoo provided more animals for refuges in Montana and South Dakota.

Today a permanent and steady total of 20,000 to 30,000 bison exists, largely in refuges and parks and most with Bronx Zoo blood.

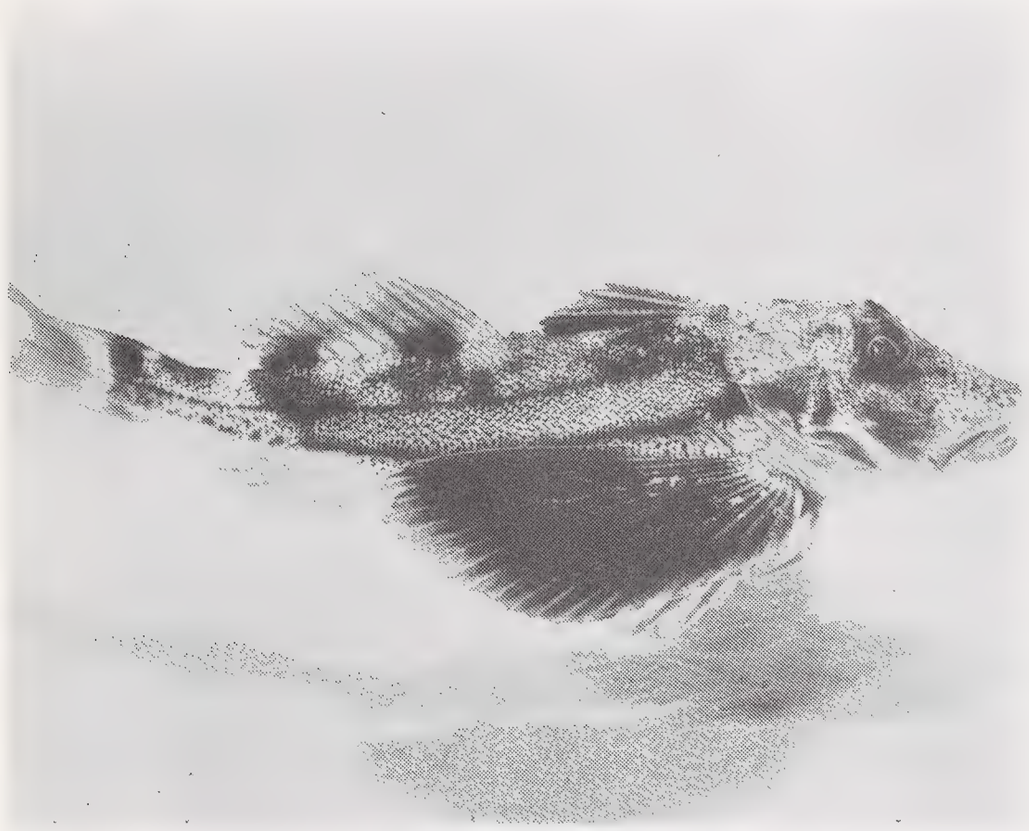
NYZS BOARD OF TRUSTEES ELECTS NEW OFFICER AND NEW TRUSTEE

Charles W. Nichols, Jr., has been elected a vice-president of the New York Zoological Society at a meeting of the board of trustees, it was announced by Robert G. Goelet, the society's president. John Macomber was elected to the board of trustees at the same meeting.

Mr. Nichols was elected to the board of trustees in 1966 and became chairman of the conservation committee in 1969. A life-long resident of New York City, he is chairman of the board of Nichols

Engineering and Research Corporation. Mr. Nichols has made a series of trips to wildlife areas, including Africa and the Galapagos Islands. In addition to his interest in conservation, he is chairman of the board of managers of Greenwich House, and vice-chairman of the board of trustees of New York University. A graduate of Williams College, Mr. Nichols is married and has three children.

Mr. Macomber, a native of Rochester, N. Y., has been associated with McKinsey and Company, Inc., international management consultants, since 1954. His other interests include the Council on Foreign Relations and the New York Philharmonic, of which he is a director. Mr. Macomber, a graduate of Yale University and Harvard Business School, resides with his wife and two children in New York City.



SOME FISHES "SING" TOO

Few salt water fishermen in this region have not come up with a sea robin on the end of the line at one time or another. However, for non-anglers, who may not have seen one of these unusual fish before, two dozen sea robins have been placed on exhibit at the New York Aquarium.

The sea robin, a bottom-dwelling fish that is found in warm and temperate waters around the world, has a reputation as a bait stealer. However, it is good-eating but seldom appears on the table because of its unappetizing appearance.

Sea robins roam the bottom in large schools, sometimes literally running along the bottom on the long rays that extend like sensitive fingers from their pectoral fins.

About 16-inches long at most, the sea robin feeds largely on small crustaceans. It is a noisy creature, producing sounds by means of muscles attached to the gasbladder.

The sea robins at the aquarium are in an exhibit of fish of local marine waters. These include striped bass, blackfish, cunners, and flounders.

NYZS STAFF PROMOTIONS

Promotions of three members of the New York Zoological Society staff have been announced by William G. Conway, general director of the society.

Anthony F. DeSiena, 27, who has been accounting manager of society since 1969, has been appointed assistant comptroller. John L. Behler, 28, has been promoted to assistant curator of herpetology at the Bronx Zoo, and H. Douglas Kemper, 26, has been promoted to assistant curator of the New York Aquarium. Both Mr. Behler and Mr. Kemper joined the society as zoologists under a curatorial trainee program supported by the New York State Council on the Arts.

Mr. DeSiena, a life-long resident of Newark, N.J., was assistant to the director of finance for that city before joining the society. He is a 1965 graduate of Seton Hall University, has an M.B.A. from Fairleigh Dickinson University, and is studying for his Ph.D at Fordham University. He is a member of the American Management Association and the Institute of Public Accountants. Mr. DeSiena is married and has two children.

Mr. Behler, a native of Bethlehem, Pa., is a 1966 graduate of the University of Miami (Fla.) and has a M.Ed. (1968) from East Stroudsburg State College (Pa.). Prior to joining the society, he was a biology instructor at Hobart and William Smith Colleges, Geneva, N.Y. He is a member of the American Society of Ichthyologists and Herpetologists, the Herpetologists League, and the Pennsylvania Academy of Sciences. Mr. Behler, his wife, and their two children live in Briarcliff Manor, N.Y.

Mr. Kemper is a 1968 graduate of Oklahoma City University and served in the United States Air Force as a first lieutenant. A native of Lawton, Oklahoma, he was supervisor of reptiles at the Oklahoma City Zoo before joining the society. Mr. Kemper is married and lives in Brooklyn.

AQUARIUM VOLUNTEERS AT WORK

Twenty-eight high school students and three adult volunteers are answering a wide variety of questions on aquatic life for visitors at the New York Aquarium.

The volunteers, who were obtained through com-

munity centers and Brooklyn high schools, are stationed at various exhibits, man an information booth, and conduct a daily story hour for young aquarium visitors.

The story hour will include demonstrations, with live animals, and aquatic puppet show, lectures on how to set up a freshwater aquarium, and audience participation skits.

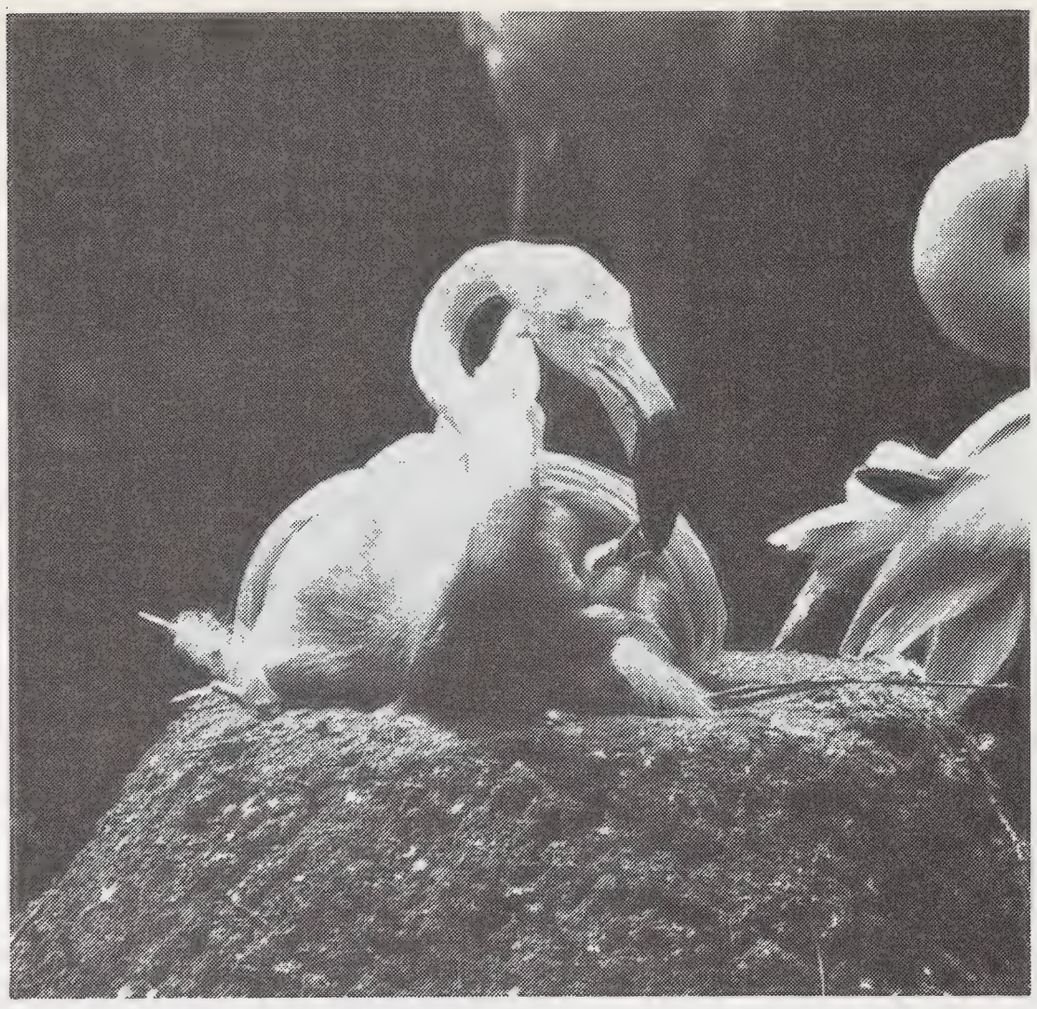
Twenty of the student volunteers, who range in age from 14 to 17 years, represent John Dewey High School, which has had a cooperative marine biology program with the aquarium.

The volunteers were given an intensive training program for two days. During this time, they were given lectures on all representative groups of animals exhibited in the aquarium (mammals, fish, birds, reptiles, and invertebrates), on collection and care of the animals, and a behind-the-scenes tour of the institution. They also were briefed on aquatic ecology in a session that included an ecological tour of the aquarium and the adjacent Coney Island beach.

After their training period, the volunteers spent a week studying the exhibits and animals to which they were assigned. The volunteers work from Mondays through Fridays weekly. The volunteer program was developed under the direction of Miss Karen Hensel, specialist in zoology at the aquarium.

BUT, WILL IT LAST?

These young gorillas are investigating their new quarters in the Great Apes building at the Bronx Zoo. The spacious area resembles their native habitat in equatorial Africa. It is the first attempt by any zoological park in the world to construct a simulated natural setting for gorillas.



FLAMINGO CHICK HATCHES ON POND AT THE BRONX ZOO

A West Indian flamingo mother keeps a wary eye on the photographer and a protective wing over her small white chick at the Bronx Zoo. The chick hatched June 27 in the conical mud nest built in the Flamingo Pond, outside the zoo's Aquatic Birds Building. Of the six kinds of flamingos – all of which are on exhibit at the Bronx Zoo – the West Indian adult is the only really red one in color. It stands nearly five feet tall, and ranges from the Bahamas through Cuba and Yucatan and northeastern South America, with a small population in the Galapagos Islands.

TWO NEW TRAINING PROGRAMS FOR VOLUNTEER GUIDES

Two training sessions for prospective volunteer guides for the Bronx Zoo, the Central Park Zoo, and the New York Aquarium will begin at the Bronx Zoo in October. One session, beginning October 13, will be held during the week. A second session will meet on weekends, starting October 16.

Training will consist of a lecture and tour each week for eight weeks, plus several workshops. After completion of training, the volunteers will serve as guide-lecturers for school classes and other organized groups, work in information booths, and give lectures for special exhibits.

Anyone wishing to serve as a volunteer should contact the Volunteer Guide Program, New York Zoological Society, Bronx, New York 10460 (telephone: 933-1500).

THE bookshelf

THE WORLD OF THE JAGUAR. By Richard Perry. Taplinger Publishing Company, New York, 1970. $6.50.

This is a rather disappointing book on the least known of the large cats. The natural history of South American wildlife has been for the most part sadly neglected. One has high hopes for a book such as this one. Unfortunately, although the author has researched a great deal of literature, it has been used indiscriminately in this book and little is learned of this magnificent cat. James Doherty

BIG FLEAS HAVE LITTLE FLEAS, OR WHO'S WHO AMONG THE PROTOZOA. By Robert Hegner; with a new introduction by Reginald D. Manwell, Professor (Emeritus) of Zoology, Syracuse University. 285 pp., 127 cartoons as illustrations plus numerous line drawings of various types of protozoa. Dover Publications, Inc., New York, 1970. $2.00.

This is a reprint of a book originally published in 1938 by Robert Hegner, one of America's great zoologists and a teacher at Johns Hopkins University. Professor Hegner died in 1943.

Although the cartoons used to illustrate the various principles in protozoology are humorous, the subject matter is serious. For example, one cartoon shows a chef carrying a steak on a platter with a sign in the background which says "Today's Special Protozoa Steak." The legend to this figures states simply "Millions of ciliates are digested, absorbed and assimilated by cattle daily so that we may have well-flavored steaks to eat." The text describes these ciliates and the role they play in the "microecology" of the intestine of cattle.

This paperback book is recommended to all, and especially to high school and college students. Even some of our more sophisticated molecular biologists would learn more about these fascinating animals than they could from their electron microscopic pictures. R.F. Nigrelli

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ABOUT THE authors

Joseph Bell is associate curator of ornithology at the Bronx Zoo. **G. Earl Chace** is curator of the Black Hills Reptile Gardens in Rapid City, South Dakota. Ornithologist **William G. Conway** is general director of the New York Zoological Society. **H. Douglas Kemper** is assistant curator and **Werner Schreiner** is a managerie keeper, both at the New York Aquarium.

ILLUSTRATION CREDITS

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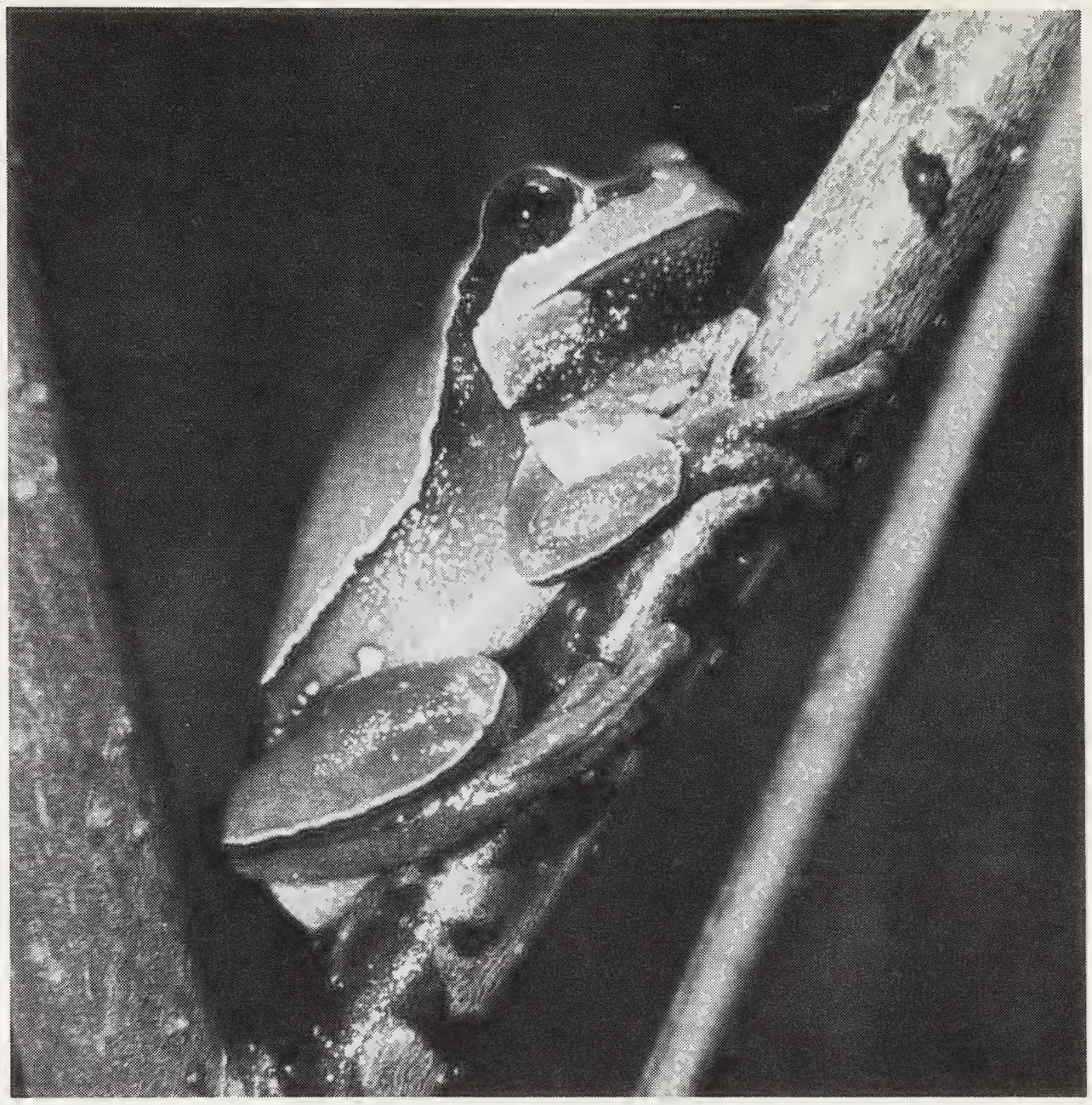
Design by Peter Oldenburg

dying species...

"The beauty and genius of a work of art may be reconceived though its first material expression be destroyed; a vanished harmony may yet again inspire the composer; but when the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can be again."

William Beebe
First curator of birds, Bronx Zoo



PINE BARRENS TREEFROG
Hyla andersoni

The time is night, the location not far from metropolitan New York City. Back and forth across the dozen yards of sphagnum mat separating them, two male treefrogs broadcast their presence to silent females. From calling stations atop high-bush blueberry and sapling red maples, additional voices join the chorus as dusk turns to night. Close investigation reveals that these unfrog-like sounds belong to the diminutive Pine Barrens treefrog. In the distance, other distinctive amphibian voices are added to the clamour. From the surface of the bog's brown-stained acid waters comes the hammer-tapping call of the carpenter frog. Now and again, Fowler's toads and green frogs make contributions. However, not all of the night voices belong to the amphibians, as the tireless vocalizations of the whip-poor-will can be heard reverberating between sandy roosting places among the pitch pine and blackjack oak.

Each year, this Pine Barren's scenario is repeated. Unfortunately, however, with each passing year the participants decline in number. The reasons for their decline are quite clear. This unique ecological community, which once equaled 2000 square miles in area, and ranged to within 25 miles of Philadelphia and 35 miles of New York, is threatened with exploitation.

Of great concern to conservationists are the fragmented populations of the Pine Barrens treefrog. This species, unlike other amphibian residents of this southern New Jersey region, is almost entirely restricted to small acid pools and sluggish brown water streams. Today, because of rapidly developing housing and industrial complexes and the practice of manipulating lake levels for recreational purposes, many of the breeding spots have disappeared. In recognition of the odds against this form, both the International Union for the Conservation of Nature and Natural Resources and the United States Department of Interior include the Pine Barrens treefrog on their rare and endangered species lists.

Scarcely an inch-and-a-half in length, this frog, *Hyla andersoni*, frequently avoids the detection of those who seek it. During daylight hours it remains hidden in a crouched position with arms and legs drawn closely to its sides, its exposed bright green dorsal surface blending into the surrounding vegetation. However, the patient investigator who stalks calling males at night will witness the startling and fascinating colors displayed by this species.

A beam of light reveals its bright orange-colored thighs and underarms, and the white bordered lavender strip which runs from the nostrils, through the eye, and down along the sides of the body. Unquestionably, this rarely seen hylid is one of America's most attractive frogs.

Differing from the explosive spring breeders, like the American toad and spotted salamander, the Pine Barrens treefrog has a protracted breeding season lasting from May until mid-July. During this period, nearly 1000 eggs may be deposited by the female. After being externally fertilized by the attending male, the eggs fall singly to the bottom of the shallow acid basin where they adhere to submerged sphagnum or decaying debris. Hatching and development of tadpoles proceeds much as it does in other pond breeding species and larvae metamorphose to the terrestrial stage during the last days of July.

Although tiny populations of *Hyla andersoni* have been found in southern North Carolina and recently from one locality in the Florida panhandle, this treefrog belongs essentially to southern New Jersey's vanishing wilderness. There is still time to save this species and its environment. Hopefully, land acquisition and protective legislation will rescue the Pine Barrens treefrog from the jaws of extinction.

JOHN L. BEHLER

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animal kingdom

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Front: The bluefish *(Pomatomus saltatrix)* — or "chopper" to the saltwater angler — has cavorted off-shore hereabouts all summer. Sports fishermen seek this rapacious and hard-fighting creature on the open water or cast for it from shores. Few sights are more thrilling than that of a big school of blues surging into shallow waters of an estuary after droves of baitfish. But the estuary, like so many other marine environments, is threatened. Ed Edelson tells the story on page 2. The bluefish pictured on the cover was photographed at the New York Aquarium.

Back: Short-billed toucan *(Ramphastos sulfuratus brevicarinatus)*, from Guatemala to Colombia and Venezula, as painted by Lloyd Sandford. For more on the artist and his work, see page 13.

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To the geographer, an estuary is the place where a river meets the sea – a semi-enclosed pool where fresh and salt water mix under the varying conditions of time, tide, and geography. To the biologist, an estuary is a habitat that sets strict standards for living creatures, but rewards those that measure up with an abundance of nutrients. To most other people, an estuary is simply a good place to do business – an excellent spot to build a port, factory, or electric-generating plant; a fine location for dumping industrial wastes, sewage, and the other detritus of civilization.

And so estuaries are a study in great contrasts. Environmentally, they range from the ultrapolluted harbors of the world's large cities to the crystalline waters of Scandanavian fjords. But even without man's altering hand, estuaries would still provide an endless variety for study, since their characteristics differ enormously from river to river.

Nevertheless, the study of estuaries is not nearly as advanced as it should be, in the opinion of many scientists. In part, that is because an estuary is literally neither here nor there – neither all salt water nor all fresh, and thus falling between the domain of the limnologist and the oceanographer. In addition, there is an even more basic scientific conflict, this one between the geographer, who is interested in the complex study of water flow and mixing within the estuary, and the biologist, who is interested in the estuary's living inhabitants. Those subjects are clearly interrelated, but the two scientific disciplines still work largely in isolation.

There is even a problem in arriving at a common definition. Geographers generally accept a distinction between a delta, where silt deposited at the river's mouth builds into great, flat deposits, and an estuary, which is regarded as essentially a drowned river valley. To biologists, this distinction is basically unimportant, since life is governed by the same conditions in both kinds of geographical formation.

Those conditions depend to a great extent on the velocity of flow of the river. In a slow-moving river, the estuary consists of two separate layers of water: an upper stratum of fresh water almost completely separated from a bottom wedge of oceanic salt water of greater specific density. A bottom layer of salt water can be found surprisingly far upstream in some rivers; in the Mississippi, for example, the saltwater wedge extends almost 40 miles from the river's mouth.

As the velocity of flow increases, more and more mixing occurs between salt and fresh water. In some cases, the mixing is essentially complete. Often, friction between the two layers of water is great enough to create surface eddies in the estuary.

The Estuary
A Fragile Complexity

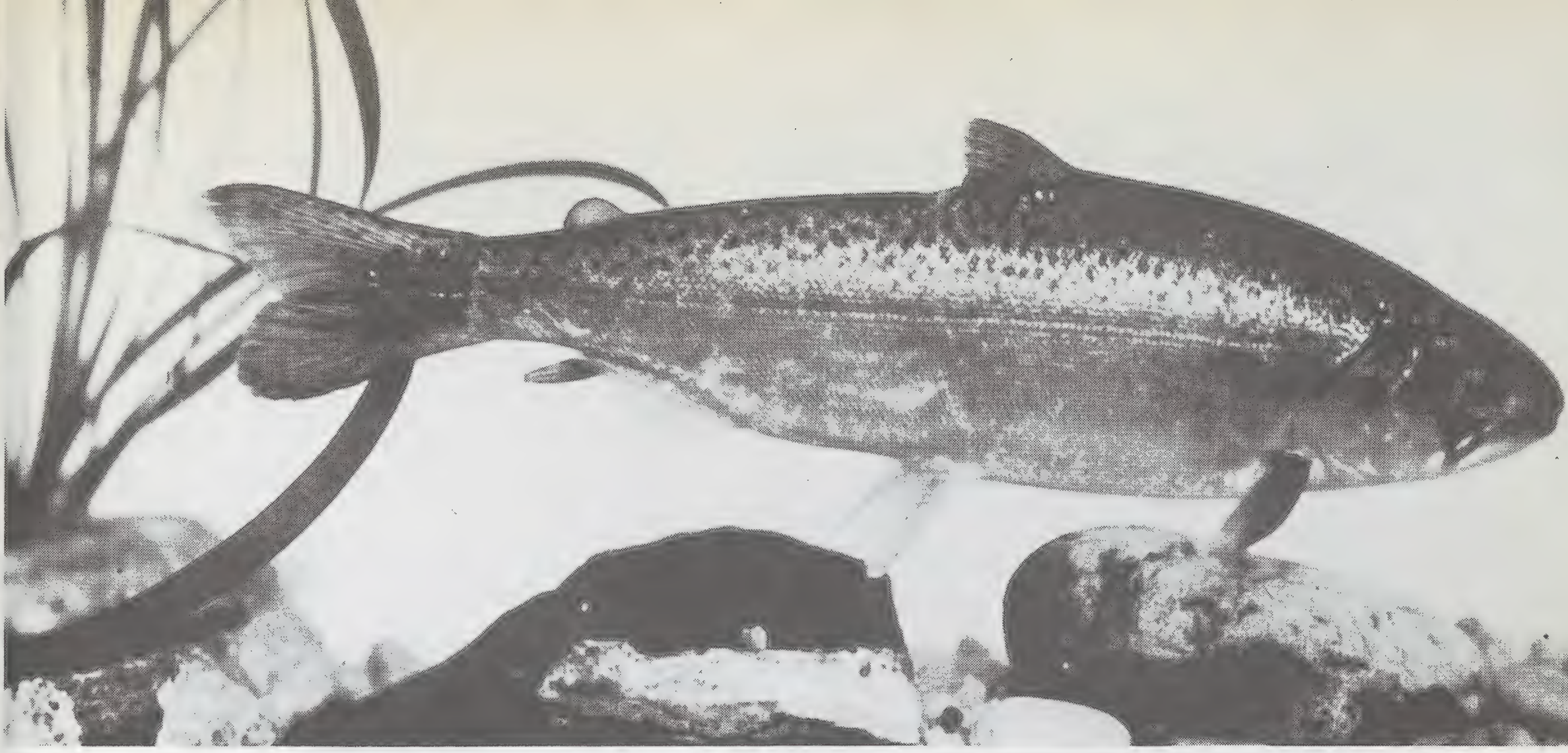
by Edward Edelson

Atlantic salmon (at right top) and Atlantic sturgeon (center), spawn upstream. The young pass through estuaries on their way to the sea. The American eel (bottom), which spawns at sea, is commonly found in and around estuaries as an adult.

Aside from river flow, the force of the tides must also be considered. Every 12 hours, a surge of salt water enters the estuary. Again, its effects may be felt far upstream – 600 miles upstream in the case of the Amazon river, where several succeeding tides travel up the river at the same time.

Finally, there is the Coriolis force – the torque created by the revolution of the earth. In the Northern Hemisphere, the Coriolis effect pushes seawater further up the left-hand side of the estuary, looking out to sea; the effect is the opposite in the Southern Hemisphere. The Coriolis force can have a surprisingly large effect. In Cheasapeake Bay, for example, points of equal salinity may be 40 or 50 miles apart on the two sides of the bay.

The life of an estuary must be set in this geographical contest. In the abstract, an estuary might appear to be almost ideal for all living creatures. The water is generally shallow, so that ample light is available for photosynthesis. Turbulence is an excellent method of increasing oxygen distribution in



water, so that most estuaries are oxygen-rich. The heavy deposits of silt and mud laid down by many rivers also encourage an abundance of life.

The joker in this deck is the conflict between fresh water and salt. Any living creature, freshwater or marine, must keep the concentration of salts in its body fluids within narrow limits. For saltwater animals, surrounded by water that is saltier than their own cells, this requirement is met by highly efficient methods of excluding or excreting excess salt. Freshwater animals, by contrast, have equally efficient methods of concentrating salts and excreting excess water.

Living in an estuary is not as simple as taking these opposing requirements and dividing by two. The salinity of an estuary changes constantly – not only by seasons (salt content goes down in the spring, when river flow increases) but daily as well, as the tides sweep in and out. Marine animals must also contend with temperature changes much greater than those found in the ocean. These conditions make most estuaries stress environments that require a degree of adaptability found in few living creatures.

One way to avoid this challenge is to go underground, burrowing into the mudflats found in many estuaries. One of the most fascinating creatures that adopts this method is *Urechis caupo,* also called the "fat innkeeper," a worm whose burrow can be found on estuarine mudflats in California. Every few hours, *Urechis* secretes a funnel of transparent mucus attached to the mouth of its burrow. It then

The blue crab, a table delicacy, is an inhabitat of the estuary. Pollution has caused this crustacean to dwindle in numbers in many areas.

pumps water by peristalsis through the funnel, whose fine pores are clogged with particles of food.

Urechis then eats the mucus tube and the smaller food particles that it holds. The larger particles go to the guests that are almost invariably found in the aptly-named "innkeeper's" burrow: most often specific species of goby, crabs, and worms. A number of other burrowing worms, whose habits are less picturesque, are commonly found in the mud and sand of the estuary.

As for higher forms of life, most fishes in an estuary are just passing through – salmon, shad, and sturgeon, which go downstream when young on the way to the ocean and adulthood, returning later in life to spawn; or eels, whose life cycle is just the reverse.

Still, there is an abundance of some animals – the crabs, the oysters, the scallops, the prawns – which can find one way or another of accepting the richness offered by the estuary while avoiding the pitfalls. Generally, these animals dwell on the bottom of the estuary, where the variation in salinity and temperature is minimized. Some, such as the mussel and scallop, are capable of moving or swimming, but the oyster – perhaps the most abundant estuarine mollusk – enjoys that ability only early in life, soon anchoring itself permanently to something solid. Crabs and shrimp come and go with the tides.

Above the estuary are the birds which take advantage of this rich food supply. The American oystercatcher, *Haematopus palliatus,* found on both coasts of North America and South America, uses its long, powerful bill to open both oysters and clams. Plovers and curlews feed on any number of small invertebrates.

No study of estuaries can leave out man as a predator. From earliest times, as ancient middens of shells prove, man has taken advantage of the estuarian food supply. That is no less true today. Crabs, scallops, oysters, shrimps still are harvested in abundance.

In fact, the estuary is among the few places where man practices true aquiculture. The most common example is the raising of oysters, which in many areas have become almost domesticated animals. The oyster farmer provides the larvae with good places to settle, such as old oyster shells, and then transplants them to new grounds to let them grow until they are harvested. Not much has changed from Roman times, when oysters were frequently raised on implanted stakes.

Unfortunately, there is as little wisdom being applied to ensure the continuing benefits of the estuarine food supply as in most other areas of human activity. Pollution from factories and human sewage has ruined many of the productive oyster beds. Even when shellfish survive, they often cannot be eaten because of the danger of hepatitis. More recently, estuarine biologists have begun studying the future effects of the heated water discharged by electric-generating plants, which are being built in great numbers to meet the nation's power needs.

A major handicap in fighting pollution is lack of knowledge about estuaries – a lack that shows up in several more subtle examples of man's effect on the estuary.

For example, the generals who ordered the massive defoliation effort in Vietnam obviously were considering American lives, not coastal waters. A recent study by a committee of the American Association for the Advancement of Science found that the defoliation program has eliminated a fifth of the mangrove thickets that line Vietnam's estuarine waters. Mangroves usually are land-building plants; establishing themselves in brackish waters, they entrap sediment in their elevated roots, gradually accumulating soil. The defoliation program has ended this process, with no indication available yet as to the ultimate implications of the massive plant kill.

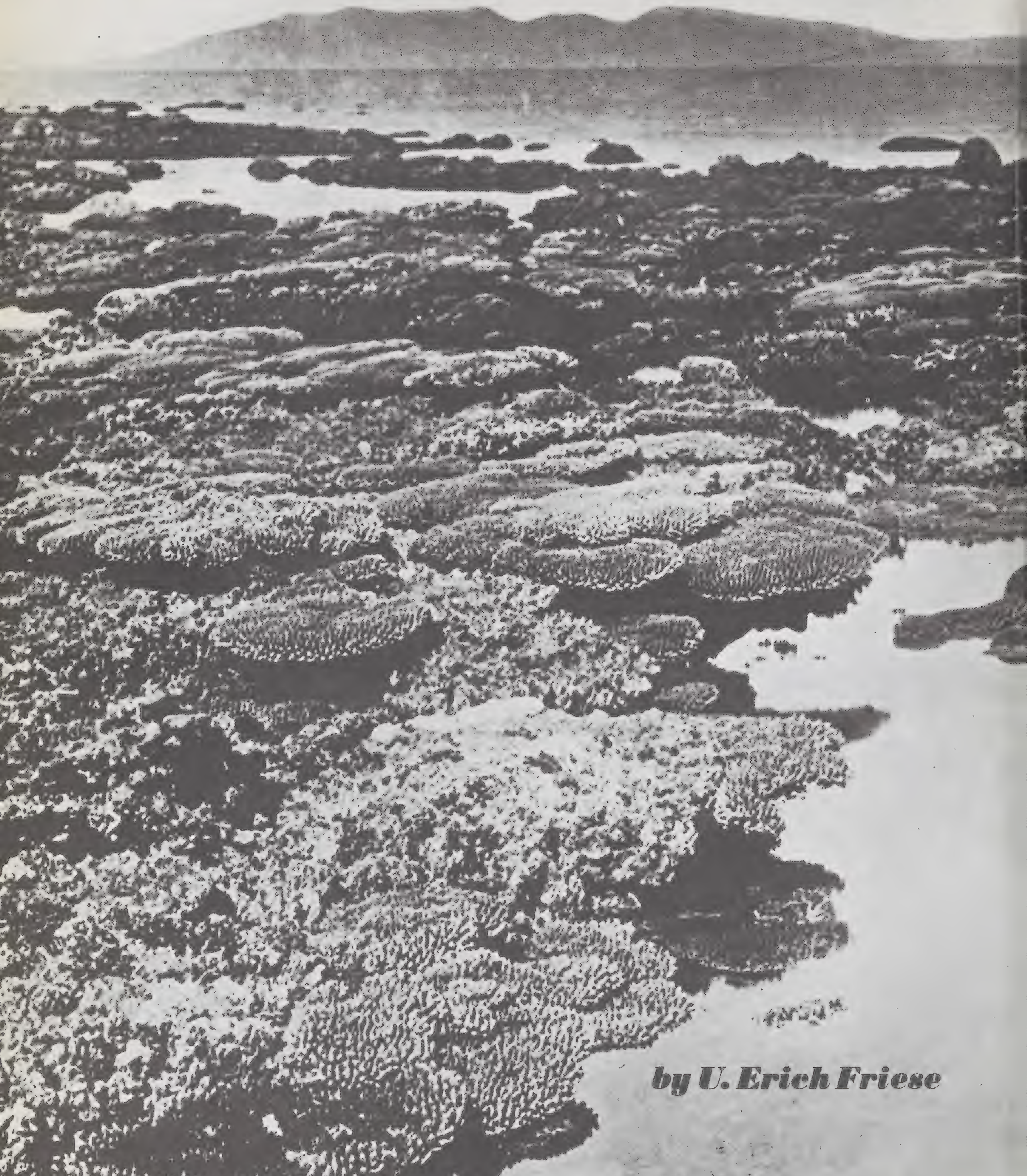
The Aswan High Dam in Egypt has produced equally unpredictable effects. By reducing the flow of the Nile River, the dam has allowed salty Mediterranean water to move further upstream, killing freshwater vegetation. As a result, erosion is claiming once-fertile farmlands in the Delta area.

Even in the 19th century, there was an example of the unpredictability of man's actions in an estuary. When the old London Bridge, with its huge piers, was removed in the 1830s, tidal flow immediately increased by 25 percent, deepening the harbor channel and causing concern for the stability of other bridges on the Thames.

As it turned out, the removal of London Bridge worked out well, since it allowed sewage and other pollutants to be swept out to sea more freely. And in the last few years, strenuous efforts have helped bring some fish back to the Thames – proof that pollution is not inevitable, even in today's highly industrialized society.

On the other hand, too few of the decision-makers who determine the fate of our estuaries realize just how fragile and complex the web of life is in these changeable bodies of water. Not only more information and better cooperation among scientists, but eternal vigilance as well is needed to preserve the life of the estuary.

Scourge of the Coral Reefs:



by U. Erich Friese

The Crown-of-Thorns Sea Star

The crown-of-thorns sea star has an armor of sharp spines with venom that can cause great discomfort to humans wounded by the spines.

On Tuesday, November 17, 1970, *The Sun* of Sydney, Australia, headlined an article "STARFISH THREAT TO PACIFIC ISLES," that claimed the crown-of-thorns starfish, or as it is more accurately called, sea star, "could lead to the destruction of many Pacific atolls . . . ." A few weeks earlier, an article appeared in the *New Guinea Bulletin,* saying that this infamous sea star occurred in above-normal numbers on the reefs of the mainland coastal regions of Papua-New Guinea and among the New Guinea islands. It was pointed out that the same species had already destroyed reefs off New Hanover Island, north of New Ireland. The echinoderm also was reported to be attacking reefs near Port Moresby, Samarai, Wewak, Manus, and Siassi Islands. The *Bulletin* said that the current rate of destruction was as much as two square feet a day for each sea star. It was feared that fishing – the livelihood of many islanders – would rapidly deteriorate once the coral had been destroyed.

Over: Australia's Great Barrier Reef is under assault by the crown-of-thorns sea star, a voracious coral-feeder.

The above are just two items out of an avalanche of news coverage around the world by newspapers, radio, and television, on what is now almost universally regarded as a plague of the coral-devouring sea star, *Acanthaster planci.*

What is really happening to the enchanting coral reefs of the tropical Pacific Ocean? Where did these sea stars come from, and what has caused this species to explode into such fantastic numbers? Can this phenomenon be stopped before it is too late? These are just a few of the questions asked with increasing frequency by those who are concerned. Many theories, hypotheses, and explanations have been offered by scientists, conservationists, fishermen, tourists, and just about anyone else who has ever seen and enjoyed the scenic beauty and the splendor of color, the vivaciousness and the abundance of marine life on a tropical coral reef.

Has the situation really changed so suddenly and without any warning? Has the crown-of-thorns sea star appeared practically out of nowhere? Not really. *Acanthaster planci* has been known to zoologists for many years. Its natural range seems to be centered in the tropical Indo-Pacific region, extending from the southern Indian Ocean (*A. planci* also occurs in the Red Sea), through the Australian archipelago to the Hawaiian Islands. Despite its wide range, this echinoderm seems to have been relatively rare before 1950. The Albatross Expedition conducted throughout the South Pacific from 1907 to 1910 collected a total of four crown-of-thorns.

In 1813, the famous sea star-specialist H. L. Clark managed to find only three specimens, and in 1928-29, the Great Barrier Reef Expedition discovered only a single specimen. More recently, Dr. Robert Endean, one of the leading authorities on the present *A. planci* problem, was reported to have found only four specimens during 18 years of field work on the Great Barrier Reef prior to the recent infestation.

The coloration of this echinoderm is somewhat variable, from reddish-brown to grayish-brown, and occasionally even a rather flat gray with a slight pale blue tinge. Its upper surface is covered with a multitude of hard but moveable spines that can measure up to three-quarters of an inch in the adult specimens. Such inconspicuous coloration, enhanced by the prickly appearance, makes this sea star quite hard to detect, and since it may occur in fairly shallow water, it can be a definite hazard to the unwary swimmer or diver. The spines have a venom in them, and people stung by the spines have reported intense pain, swelling, infections, and even nausea and vomiting.

The crown-of-thorns is one of the largest sea stars in the world. Older specimens may measure in excess of 15 to 18 inches across, with about 18 arms. It is extremely mobile. Repeated experiments at the Taronga Zoo Aquarium in Sydney have shown an 18-arm specimen requires 43 seconds to cover a 12-inch distance. Another specimen, slightly smaller and with only 14 arms, took 46 seconds to cover the 12 inches.

While most species of sea stars feed on various mollusks, such as snails, clams, and mussels, the crown-of-thorns feeds on live coral polyps. This is quite an extraordinary feat since the coral polyp lives well protected inside a solid calcareous skeleton. Yet, such an obstacle is relatively easily overcome by this sea star. It everts its membranous stomach through its mouth and spreads it over the coral polyp. Digestive juices then start pouring over the polyp, liquifying it completely, and the liquid is then absorbed by the animal. Once all the polyps are eaten on a coral head, the stomach is retracted, and the sea star moves on to another coral head.

All that is left of a reef after a grazing herd of these echinoderms has moved on are sad remnants of a once-colorful living structure. Observers have described reefs attacked by the crown-of-thorns sea star as resembling long-forgotten marine graveyards or the aftermath of a forest fire. Where there were once spectacular coral formations, there are now many vast patches of dead or dying coral. Robbed of its structural support by many empty coral heads, large lumps of branching coral have fallen to the sea floor. Huge brain coral heads are now ugly, chalky-gray lumps. Many of the colorful reef fishes are gone, and brown algae covers the once proud reefs. Interestingly enough, only two other sea star species feed on coral polyps, the armless pincushion sea star, *Culcita,* and the Panama spiny sea star, *Nidorellia.*

Substantial numbers of the crown-of-thorns sea star began to occur in widely separated parts of the Indo-Pacific after 1950, but it was not known until 1961 that *Acanthaster planci* was actually feeding on coral polyps, when observations were made by Israeli scientists working in the Red Sea. By 1962 scientists in Australia became aware of the potential problem, as crown-of-thorns sea star attacks were observed upon reefs off Cooktown, on the north-eastern coast. Shortly thereafter this species was suddenly seen feeding on the live coral outside the windows of the Green Island Underwater Observatory, off Cairns, to the south.

As the sea stars ate up the coral reefs, they moved south, where great masses of them engulfed more than 100 smaller coral reefs between Cooktown and Townsville. There, over a distance of about 300 miles, more than 90 percent of the coral has been killed. It is estimated that within the next two to three years, all inner patch and fringing reefs of the Great Barrier Reef between Cooktown and Townsville will be destroyed. Reports of devastations have also come from the southern parts of the Great Barrier Reef. Dr. Endean has estimated that altogether about 10 percent of the 2,500-odd separate reefs constituting the Great Barrier Reef have been affected by this plague.

While *Acanthaster planci* moves over the Great Barrier Reef, similar invasions are occurring throughout the South Pacific. Substantial numbers of sea stars have been found on reefs from the island of Yap at the far north of New Guinea, northward to the Marianas, east to the Marshall Islands, south-east to the Gilbert Islands, the Solomon Islands, Rabaul, Tahiti, and in Hawaii.

During preliminary scientific investigations, certain descriptive standards have been established. When 100 specimens of the crown-of-thorns can be counted by one diver within a 100-minute period, one may reasonably speak of the sea star as occurring in plague proportions. Yet, at the Frankland Islands off Innisfail, 8,100 specimens have been sighted within one such 100-minute period. Hardest hit so far appears to be the island of Guam, where an estimated 95 percent of the coral reefs have been destroyed over a distance of about 30 miles along one side of the island. A density of one sea star per square meter of reef area has been observed there, and a four-man diving team once removed 2,589 specimens in four hours.

Despite valiant short-term measures, such as the physical removal of *Acanthaster planci* from the reefs by divers or killing the sea stars by injecting them with formalin as they crawl over the reefs, the overall devastation of coral reefs throughout the South Pacific continues more or less unchecked. At this stage it appears to be an uncontrollable problem, and scientific investigators are urgently looking for some positive answers. In order to control and explain animal population explosions, one looks intuitively first at the life history of the animal concerned. Quite often an understanding of the life cycle of an animal will supply answers about its control. How does the crown-of-thorns sea star reproduce in the sea?

Eggs and sperm of *Acanthaster planci* are shed into the open sea, where the fertilization takes place. The fertilized egg, while still drifting in the ocean currents, develops into a tiny larva, the bipin-

naria, typical of sea stars. The bipinnaria stage lasts for about 16 days during which – although the larva has a limited ability to swim – it may be carried hundreds of miles by ocean currents. The defenceless larva is very vulnerable and is preyed upon by many species of zooplankton, but this hazard is one to which most sea stars are exposed and they meet it by producing myriads of young.

The bipinnaria stage is followed by metamorphosis, during which the larva settles out of the planktonic community and becomes a bottom-dwelling creature. For best chances of survival, this stage must settle onto a coral reef but, even here, there are also many predators. While sinking to the bottom, the starfish larva comes within the range of millions of filter feeders, those animals which strain tiny food particles from the sea water. Once the larva has actually reached the bottom, detritus feeders and scavengers come into action against it. These include most coral polyp species, sea anemones, sponges, mollusks, and some echinoderms.

When metamorphosis is completed and the bottom-dwelling larva becomes a miniature sea star, it enters a rather cryptic phase. Although there are no known predators at this stage, it is likely that sea anemones, annelid worms, and others may feed on the young sea star, despite its armor of tiny spines. However, as the animal matures, the number of possible predators decreases. The giant triton shell, *Charonia tritonis,* is the only confirmed predator of adult *A. planci.* Other mollusks, such as *Cassis* and *Murex,* have been observed feeding on the crown-of-thorns sea star in captivity. They may not, however, be active predators on this species under natural conditions. One investigator has seen a large tropical sea anemone, *Stoichactis,* catch one of these sea stars and actually devour it. Probably smaller (juvenile) specimens of the crown-of-thorns are taken more frequently by sea anemones. Among fishes, only the Maori wrasse, *Cheilinus undulatus,* seems to feed occasionally on this echinoderm, judged by a number of sea star spines found imbedded in the mouth tissue of several wrasses.

Thus a multitude of marine organisms feed upon the crown-of-thorns sea star at one time or another. With such heavy predation pressure, how could the crown-of-thorns population explosion happen? It has been estimated that each adult crown-of-thorns female can produce from 12 million to 24 million eggs per year. Under normal conditions and to maintain the status quo, out of all these eggs only two of them have to survive and mature to produce one male and one female. If one assumes that the average life span of this sea star is five years, which seems to be a rather conservative estimate, an adult pair can produce about 5×10^7 eggs during their lifetime. Since there is an abundance of adult over juvenile specimens on the reef, it is obvious that the greatest mortality must occur before the sea star reaches a size of about one inch. In order to explain the apparent decline in predation pressure on *Acanthaster planci* the following hypotheses have been advanced by scientists.

• Man-made pollutants may have been increasing in the marine environment during the past few decades. These pollutants may have seriously affected planktonic predators and/or decreased the standing populations of zooplankton, which constitute the largest portion of predators on the sea star. There is, however, one basic fault with this theory. If concentrations of organo-chlorines and other man-made pollutants are affecting the zooplankton, the sea star explosion should correspond to the occurrence of such pollution. It appears though, that large populations of *A. planci* occur on a random basis.

• Man-made pollutants also may have affected the reproductive capacity of the actual predators of the adult *A. planci.* Consequently the reduction in predation pressure on the adult sea star could have led to the current population explosion.

• A substantial decrease in predation pressure during the critical settling period of the sea star larvae may have been caused by mechanical damage to the reefs. Dynamite blasting – a common fishing method on many South Pacific islands – has destroyed substantial reef areas. These breakages afford excellent and quick-settling sites for the crown-of-thorns larvae, which are quite often adjacent to lush coral growth, the necessary food for the growing sea stars. These settling sites are available only for a relatively short time, for they quickly grow over with algae. Therefore a substantial number of sea star larvae must settle at more or less the same time, creating a population of perhaps several hundred new sea stars close to an abundant food supply. One would expect such populations to be very much of about the same size. There appears to be some evidence that this may have happened in some areas of the South Pacific, but certainly not in all.

• Much emphasis has been given to the *Triton* hypothesis. Decreased predation pressure on *A. planci* is attributed to the decline of adult triton shells because of increased shell collecting. Evidence indicates there may be some substance to this theory, especially in those areas where intensive shell collecting is taking place, namely on the Great Barrier Reef and on Guam. However, experiments have shown that the triton can consume only one

adult crown-of-thorns sea star per week. It is agreed, however, that somewhat heavier predation may be exerted upon the smaller sea star specimens.

• Finally, one has to consider the possibility of certain genetic changes in *A. planci,* which, in some unusual way, may have made it more resistant to predation. Although genetic mutation could conceivably improve the chances of larval survival, there is no field evidence to this effect on hand. If true, one would find it hard to explain as to why the crown-of-thorns sea star outbreak occurred suddenly, over wide-spread areas, rather than as a gradual increase in the sea star populations.

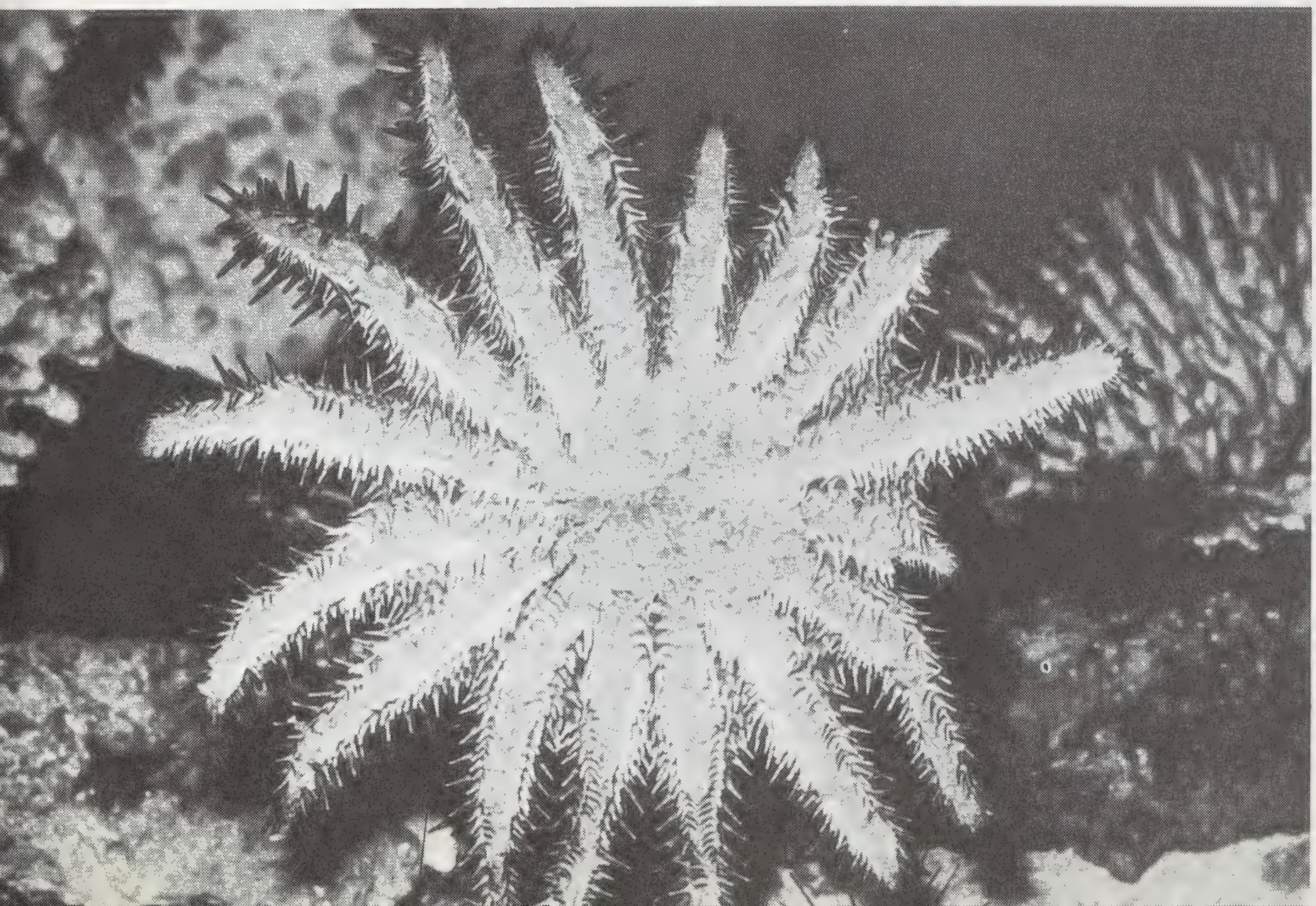
There has also been much discussion whether we are dealing with a periodically occurring, natural phenomenon. Yet, there appears to be no evidence to support a theory for cyclic recurrence of such sea star population explosions. The Great Barrier Reef has been investigated by biologists for about 100 years, and as mentioned before, only a few specimens of *A. planci* have been found. Judging by the current devastations of about 100 square miles on the Reef, it is unlikely that such damage could have gone unnoticed during the last 100 years.

The crown-of-thorns sea star's unusual features of size, coloration, and poisonous spines have made it well known to the South Sea islanders, who have various dialect names for this species. These people have been fishing the coral reefs for more than 2,000 years, and it would indeed be strange that if there had been previous large scale sea star explosions, these would not have been recorded in the usually very explicit folklore of these people. One could also argue against recent cyclic occurrence of *A. planci* with the fact that some of the recently destroyed coral formation must have required a continuous growth period of about 1,000 years. Thus, hypothesising for sea star (or any other invertebrate) cycles of more than 1,000 years appears to be without any real substance.

While it is being debated in public and within scientific circles whether the current crown-of-thorns sea star explosion is a unique phenomenon or a recurring cyclic event, it is also universally realized that something has to be done immediately in order to prevent further devastation of the precious coral reefs. The recovery of reefs is painstakingly slow; it took more than 25 years to re-establish even modest coral growth on a small Pacific island.

Furthermore, there is evidence that *Acanthaster planci* may be able to maintain resident populations for an unlimited time. This would prevent indefinitely the formation coral that serves as frame-work for the reef. Consequently, the destruction of living coral by *A. planci* predation causes long-term, often irreparable damage to the coral reef's intricate ecosystem. It is already evident that coral-feeding fish species, such as chaetodontids (butterflyfish) and serranids (grouper-like fishes), have already been replaced on those reefs destroyed by the crown-of-thorns sea star by certain algae-feeding species, such as acanthurids (tangs and surgeon fish) and scarids (parrotfish).

In order to halt further destructions of the South



The crown-of-thorns has become a popular aquarium exhibit because of its notoriety.

Pacific coral reefs, leading scientists have suggested a three-phase control program.

1) Destruction of existing *Acanthaster planci* populations by diving teams.

2) Educational programs to alert the local populations to the threat involved in large crown-of-thorns populations.

3) Intensification of scientific investigations into the general biology of *A. planci* and its predators, and inauguration of detailed studies of the dynamics of the coral-reef ecosystem.

In order to implement these suggested control measures, strong government action is needed. So far, the United States seems to have taken the lead in attempted corrective action on the crown-of-thorns sea star problem. On November 19, 1969, three members of the U. S. Senate proposed a bill that "for the purpose of conserving and protecting coral reef resources of the tropical islands of interest and concern to the United States in the Pacific and safeguarding critical island areas from possible erosion, and to safeguard future recreational and esthetic uses of Pacific coral reefs, the Secretary of the Interior and the Secretary of the Smithsonian Institution are authorized to cooperate with and provide assistance . . . in the study and control of the sea star 'crown of thorns.' "

However, to combat a problem of such magnitude, universal action is needed. Unfortunately, this is not generally forthcoming. In Australia, for example, all conservation efforts are under the control of the individual states. Thus, the Queensland government is responsible for the Great Barrier Reef, and it gives no indication of regarding the problem as either serious or urgent. In 1968 and 1969, a heated public controversy raged against the Queensland government's inaction on the sea star problem. Two official reports were submitted to the government, but neither has ever been made public, and the government has insisted that the Great Barrier Reef is not in any danger. However, the government has established a small research station at Mourilyan, near Innisfail. Research at this station is said to have led to another report confirming the previous findings, but this also has been shelved.

In April 1970, the Australian Federal Government established a joint commonwealth-state committee of inquiry into the Great Barrier Reef. Its report, made public in March 1971, neither confirms nor denies previous conclusions reached about the crown-of-thorns problem. It observed that much more research is needed before meaningful countermeasures can be implemented.

The Great Barrier Reef is immense and even if half of it were devastated, the remaining 50 percent would comprise a greater area of reef than exists over the rest of the world. Nevertheless, if as little as 10 percent of the reef has been wrecked in 10 years, the problem cannot be swept under the carpet.

Either the phenomenon that we are observing is a cyclic one, or a change in the environment is leading to a radical, and perhaps permanent, change in the balance between predator and prey. That an eventual equilibrium must be reached is a biological truism, but we do not know what this new equilibrium will be. The crown-of-thorns is capable of growing and reproducing faster than the corals upon which it feeds, and it can therefore eat itself out of house and home. A population crash in the sea star will permit regrowth of coral but unless the crown-of-thorns reverts to its obscure position of 40 years ago, the new equilibrium will involve predation upon regenerating coral.

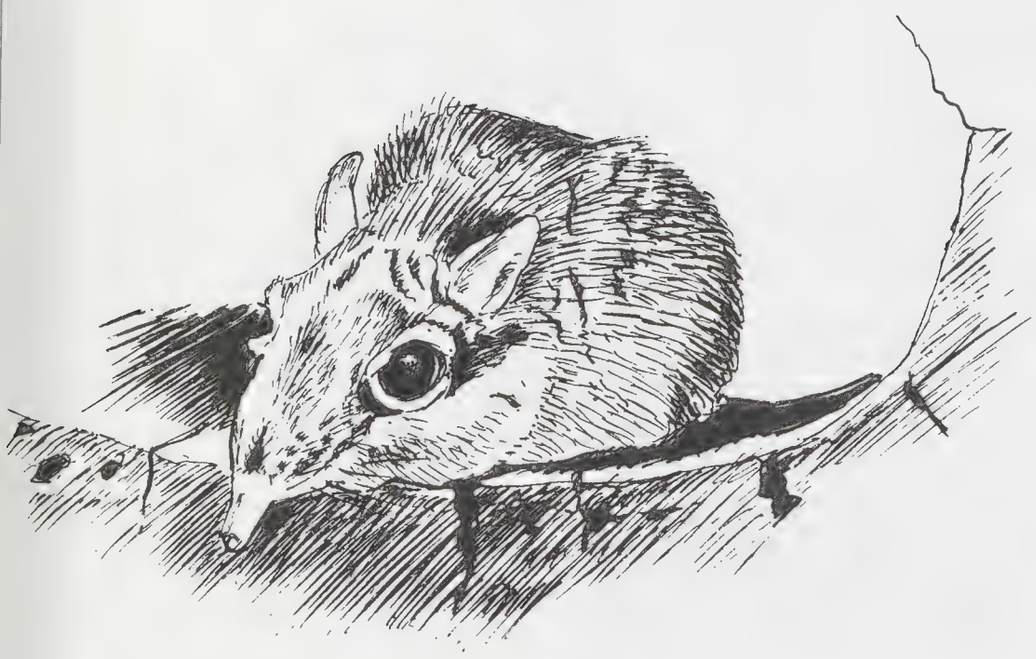
The situation will be similar to that involved in the introduction of a new and successful grazing animal into a savanna environment. Here, the initial radical devastation is followed by a reduction in the variety of plants and the emergence of a few species of well-rooted, fast growing grasses. This simplification of the plant community leads to a reduction in the complexity of the animal community, first of the smaller specialized herbivores and then of their normal predators. Finally, there is one dominant herbivore species in equilibrium with a small number of dominant grasses. The savanna has been replaced by a prairie.

To the biologist – and to the tourist – the remarkable and delightful feature of the undamaged Great Barrier Reef is that it is an extremely complex ecosystem with no dominant species. Apologists for the crown-of-thorns point with satisfaction to regeneration of corals in areas that the sea star has devastated, but they are unable to state that all of the orignal coral species are growing again. Certainly there has not been enough time to say that some have gone forever, but present indications are that the regenerated reef is akin to a prairie.

In the sense that the Great Barrier Reef is a massive geological structure, it cannot be destroyed; however, as a biological entity, it is as vulnerable as the Everglades. But, whereas the problems of the Florida swamplands are local, those faced by the people of Queensland are Pacific-wide and, although no practicable solutions can be proposed on the basis of present knowledge, it is to be hoped that Australian biologists will cooperate with those of the United States in a joint attack on the problem, rather than tackling it piecemeal.

LLOYD SANDFORD

IN MEMORIAM



Making detailed accurate drawings of animals directly from life is a painstaking job, often extremely frustrating because the subjects rarely hold the pose chosen by the artist. To Lloyd Sandford, the New York Zoological Society's staff artist from 1946 until his untimely death on July 26, 1971, the problem was strictly academic. Lloyd had two great passions in life; he loved animals and he loved to draw. He also possessed a keen eye, unusual talent, and great patience. Without this last quality he never could have succeeded in producing the thousands of drawings and paintings for which he was known.

During the hours when the Bronx Zoo was open to the public, visitors who came upon the artist at work were naturally intrigued by his skill and bound to ask many questions about the animal he was drawing, his reasons for drawing it, and the techniques that he used. Lloyd was always patient in answering the questions of children and courteous to the adults, willing to share his extensive knowledge of natural history and art with both groups. Only occasionally would he show a small amount of pique when some facetious visitor, peering over his

Sketches by Lloyd Sandford

shoulder, would ask if the picture was "hand drawn." The short, trim artist's standard answer to this query was a level, penetrating stare.

For as long as he could remember, Lloyd Sandford always wanted to be an artist. When he was about four years old, he started to draw, trying to capture on paper everything that came to his attention. As a young man, he studied at the National Academy of Design, the Newark School of Fine and Industrial Arts, and the Art Students League.

Learning about wildlife at first hand was always Lloyd's greatest hobby. He loved to be outdoors – hiking in deep woods, tramping along the ocean's edge, or making his way through the spongy back waters of a marsh – looking, listening, and always finding something new at which to wonder. Birds were his real favorites. He became expert in identifying them by sight as well as by sound, and he learned everything he could about their specific habits. Most of all he longed to draw them. This was a difficult task in the field, so he started making regular trips from his home in Newark, New Jersey, to the Bronx Zoo. Here he could draw birds to his heart's content, not only the native species that he had learned about on his field trips but also exotic forms from all over the world. His representations were so accurate that he was soon asked if he would make some drawings for the park's identification labels on a free-lance basis. This was the beginning of his lifelong career, interrupted only by a four-year stint in the army during World War II.

Following his return from service, Lloyd was offered a full-time position as zoo staff artist, a job that broadened his work area to include label drawings for all of the zoo's animal departments and the New York Aquarium. Added to this, he did art work for special graphic displays and illustrated many articles in *Animal Kingdom.* There were always more birds to be drawn than anything else, however, and room was first found in the head keeper's office of the old Large Bird House for Lloyd's drawing table. Later he moved to a small studio in the same building that had been Dr. William Beebe's old office when he was the park's first curator of birds.

It's easy to understand why Lloyd was always considered to be a member of the bird department, for he was in the bird house most of the time and could be counted on to help out with certain departmental chores. After all, he was standing there in front of the cage just drawing pictures; would he watch and make certain that the new woodpecker was eating? He was always glad to oblige with a detailed report.

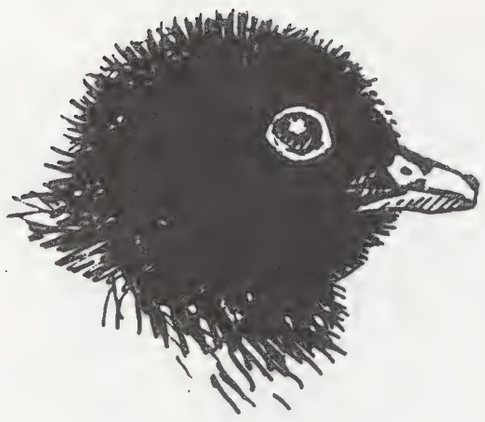
The one yearly bird department operation that Lloyd looked forward to above all others was the annual pelican roundup on Cope Lake, in the northwestern sector of the park. Pelicans out-of-doors cannot survive the rigors of New York winters, and each fall the flock must be removed from the lake to heated quarters where it remains until spring. The entire operation is accomplished by keepers in flat-bottomed, wooden boats rowing after the birds, trying to corner them, and finally capturing them with landing nets. This is a back-breaking task for the keepers, but trying to outmaneuver the waterbirds in their own element has taken on the air of a field-day sporting event. Although they are always the losers in the long run, even the pelicans seem to enjoy the contest.

Lloyd never missed a roundup, even when ice had to be broken before the boats could be launched. He was a tireless oarsman and would never relinquish his position in a boat until the last bird was captured. The curators, always interested in improving operational methods, devised a technique several years ago that would cut the time and labor involved in the roundup by a substantial margin. Sections of fencing were anchored along one side of the lake to form a kind of water corral, into which the pelicans might be driven and captured with ease. Given a trial, this system worked beautifully and the entire operation was over within minutes. Everyone was pleased, everyone that is but the keepers and Lloyd Sandford. It just wasn't sporting. A formal protest was launched, and Lloyd was in the vanguard. After a brief deliberation, it was decided to abandon the new method – a complete victory for traditionalism, rare in these modern times.

Lloyd's artistic talents were always in demand. When he returned to his home in Fair Lawn, New Jersey, each day, his wife May and two teenage children, Barry and Betty, had to share him with his second career as an illustrator of children's books, scientific articles, and field guides. His most recent work included plates in a large monograph of the diurnal birds of prey entitled *Eagles, Hawks and Falcons of the World* by Leslie Brown and Dean Amadon, and Jean Delacour's *Guide Des Oiseaux de la Nouvelle-Caledonie.*

During his career at the New York Zoological Park, Lloyd drew and painted thousands of pictures of birds, mammals, reptiles, and fish. Many of these animals are so rare that they never may be drawn from life again. These illustrations, created by the artist, are his best memorial. Lloyd Sandford was one of those rare people with a combination of great talent and good humor. We will miss him. We will never forget him.

Joseph Bell



HUNT *of the Wild Dogs*

The hunt of the Cape hunting dogs begins at dawn when the dogs stimulate each other with playful activity.

by Norman Myers

The Cape hunting dog of Africa hunts twice a day. The dog pack begins the first hunt shortly after dawn, in the first glimmerings of daylight; the second is at dusk.

Wild dog packs are not a common sight. You can live in East Africa for years and hardly ever see them. The dogs are rare, if not disappearing from the African scene. But if you go about the search in the right way, it is not too difficult to track them down. During the day the dogs rest, often huddled together in the shade of a thicket. They are well hidden and you can pass a few yards from a pack and not know the dogs are there. At first light and last light, however, the dogs are far easier to pick out than the lions, leopards, and other great hunters of the plains.

Wild dogs make no attempt to get close to their prey by stalking. They run prey to a standstill. Once they sight something, the chase is on, and may last for miles. The wildlife watcher who is up and on a hill at dawn will spot the dogs if they are around.

An area the size of Massachusetts may contain only a dozen packs. This, in a way, is a pity, for wild dogs are interesting beings, with an extraordinary system of communal-living. Unfortunately, wild dogs have suffered from a miserable reputation. They have been called rapacious and ruthless; they are accused of disturbing the game for miles around; they are labelled a blight upon nature, and excrescence that should be better obliterated. The Cape hunting dogs have been shot and poisoned wherever they are to be found.

Actually, wild dogs do not compete unduly with other hunters. The only predator that is remotely similar in its tactics is the hyena. By numbers and rank among the carnivores, the hyena occupies a different ecological place in the scheme of things. It hunts many more creatures, often different ones, and in a different fashion. If there is any conflict with the wild dogs, it is a marginal one. And if there is no other member of the hunting hierarchy to squeeze the wild dogs out of the running, the wild dogs are hardly likely to exert undue pressure on any other predator.

Wild dogs normally live in packs, each of which must consist of at least half a dozen animals to function properly. The pack operates under a highly developed mutual-support system. Smaller packs can get by – two females in the Murchison Falls area of Uganda have survived for years. An average-size pack, however, totals ten or a dozen dogs, though some packs have been known to have more than 50 animals.

Oddly enough many more male pups are born than females, or at any rate more males survive the first few weeks. In South Africa's Kruger National Park, the males outnumber the females by three to two, a remarkable imbalance. Packs occasionally are found with no mothers remaining to suckle pups. Many of the young dogs do not survive more than a few months. There are some packs where a good half of the adults are under two years old, which indicates a very high mortality rate.

The pack operates without a hierarchy. There is no dominant individual to set the trend for the other dogs, a most unusual phenomenon. More frequently one adult, such as a male among lions or a female among elephants, emerges to dominate the rest of the group. But the wild dogs operate in a system where no one is at the top, no one is at the bottom. One particular dog may start the hunting process and be the one to reach the prey more often than the rest, but it does not try to exert any forceful leadership.

Carnivores are equipped for violence – they must be to stay alive – and often enough they use their weapons, or at least the threat of them, to establish a series of social standings where every creature knows its place. This helps to prevent fights, which could eventually be harmful to the species.

There is little friction in the dog pack, but rather there is an extreme inclination to appease one another, to go out of one's way to be amicable and acceptable, and to use every form of submissive sign rather than provoke trouble. While young, the dogs indulge in a lot of fawning to beg for food. They lick the face of another dog or nuzzle it until food is regurgitated. When they mature, they repeat this approach in almost every contact with other adults. Every time one dog runs up against another, they indulge in a greeting ritual which is a hang-over from begging. It is something like the practice of wolves where one wolf greets another by taking its head in its jaws.

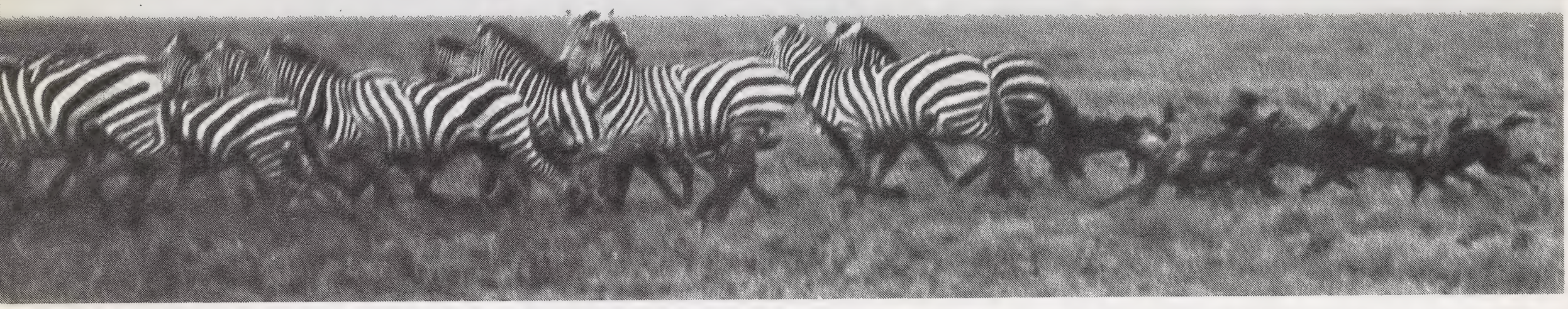
As the long African day shows itself above the horizon, the dogs start to stir. With the first streaks of early light, the pack gets restless. As the new day reaches across the savanna, one dog rouses another. They romp and play a little. They turn to one another. Soon the whole pack is leaping around. They get more and more excited, twittering among themselves. Then one sets off at an easy lope across the plains. The others follow, and the hunt begins. Their hunting technique means they have to rely almost entirely on sight. Scent and hearing are not much use to them. While most predators do some of their hunting by night, wild dogs wait for daylight unless there is a full moon.

It may take a mile before any suitable quarry is sighted. At first the dogs ignore groups of zebra or wildebeest in their path, and these animals do not show much alarm at the appearance of the dogs, but merely look on from a distance of a hundred yards or so. Suddenly one of the dogs lengthens its stride. It aims for a particular group of animals. It is not likely to be one of those casually staring at the pack. Of all the animals on the plains, only those that have been marked out turn and flee. The pack follows some way behind. Soon the dogs are strung out across the savanna – only a few of them maintain the hot pace of a flat-out chase.

The pursuit may go on at 40 miles-an-hour for one stretch of country after another, until the prey begins to weaken. Sometimes a couple of miles is enough; sometimes the chase may be two or three times as far. The dogs do not take turns to wear down the prey, as is often alleged. One dog keeps in front and others only make a strike if the prey turns or weaves. An escape tactic of this kind is tried often enough, since many prey animals have eyes at the sides of their head and tend to run in zigzags or, when they tire, change from outright flight to a series of dodges. At the start of the chase it is not clear which creature is the one to be singled out. Perhaps the dogs do not pick out any individual until it is apparent which one is unable to run as fast as the others. Wild dogs do not seem to pick on any

Once the hunt has begun, the wild dog pack wanders by numerous groups of zebra, seemingly without paying much attention to them. On this hunt, the four-month old pups join the pack. This was the first time the youngsters had left the den and they covered nine miles at a steady trot before the kill finally was made.

Suddenly for no reason discernible to the on-looker, the pack starts after one particular herd of zebra, ignoring the neighboring smaller prey, such as wildebeest and gazelle. The pack harries the whole zebra herd over a distance of a few miles at a steady 25 to 30 m.p.h., until . . .



. . . two zebras drop back from the herd and are at once singled out for special attention. The dogs harass them from all sides, seizing mouthfuls of tail and striking at the flanks. Mile after mile, the two zebras keep striding at less than full speed, steadily tiring.

individual until the pursuit is under way – but then they follow the quarry right past other antelope even within closer range, right through the middle of other herds that just stand and watch.

Wild dogs hunt by sheer speed and stamina. They run the prey till it cannot run any more. Lions and leopards hunt by some degree of stealth and surprise, as does the cheetah. However, while the cheetah has speed far beyond that of the wild dogs, it has not a fraction of their staying power.

Flee as it might, the prey is down to its last few minutes of life. It is not long before the leading dogs are snapping at its heels. Occasionally the wretched animal does try to defend itself. If it is a zebra, it may try a bit of retaliation by lunging with bared teeth. If it is a gazelle, a warthog, or a young wildebeest, it is generally too exhausted and shocked to do much. Not that fighting-back makes much difference; the end is rapid. One dog rips at the skin of the stomach, another thrusts its head right into the gap; the prey lurches forward and the contents fall out on the ground. The animal staggers and in a moment, it is torn to pieces.

A downed gazelle disappears almost right away, and may be eaten before lame or elderly members of the pack arrive. But all get their share. The latecomer produces a specially effusive greeting, pushes its muzzle into the corner of the mouth of a dog that already has fed, and promptly receives a piece of regurgitated meat. Or if the carcass is not yet consumed, the dog which arrives late may try to obtain food by showing extreme subjection to another dog. It flattens its ears, lays its head along the ground, and makes docile twittering noises. Eventually the

One of the zebras falls even farther behind and now the dogs direct all their attention to the single laggard. So far, the chase has lasted six miles in distance and slightly over a quarter of an hour in time.

The prey is attacked by three dogs from the front, while the main body of the pack moves in behind where the zebra is most vulnerable. Within four minutes, the zebra is under final assault. A hyena appears on the scene but takes no part in the kill.

The zebra falls to its knees, disabled from loss of blood and shock. The dogs move in and the end comes quickly.

other dog feels obliged to forsake its place at the meal – unless it can prove itself more submissive than the interloper. The same holds true for half-grown dogs. As soon as they arrive, the adults surrender the legs, the head, or whatever remains of the carcass. No member of the pack goes hungry.

After their meal, if there are young ones left behind, the dogs start off back to the den. Near the warren, they may be met by a guard dog or two. There is more regurgitation to feed the guards. Nearer the den, the hunters are met by the pups. Regurgitation occurs once more, even from the guard dogs that have just received their share. In fact, a piece of meat reaching the stomach of a pup may have been inside several dogs on the way from the hunt.

Wild dogs have been accused of scattering the game for miles around. When they enter an area, it is said the whole countryside promptly empties of other animals. This is a myth to go with the other myths about the dogs. Wild dogs cover large distances. If there is no den to return to, they cover 30 miles a day during their foraging expeditions. Obviously they cannot clear areas this size of other wildlife. One pack was reputed to range over 1500 square miles, and its effect could have been no more than that of other predators ranging the area in similar or, as is more likely, far greater numbers.

Sometimes a pack does not cover such a huge area. One pack of 23 dogs stayed in a range of a mere 20-square miles as long as prey was plentiful, and only extended its range to an area three or four times as large when quarry became scarce. Another pack subsisted in the Ngorongoro Crater in Tanzania for several years while using only a part of the 100 square miles available. Wild dogs do not cause much disruption while they are on the hunt, although occasionally an antelope herd may be dispersed.

Fortunately there is now some indication of the type of predation caused by wild dogs. As with lions and certain other predators, wild dogs apparently need to kill at the rate of one-and-a-half pounds a day for every ten pounds of their body-weight. The number of animals accounted for by each dog per year could vary according to the size of the pack, but it would range from 35 to 50 animals. It would also depend on the prey creature: a full-grown zebra at 500 pounds is ten times as much as a Thomson's gazelle. But a zebra does not often supply the food. In fact, few adults of the larger prey species are taken by wild dogs. The dogs prefer to go for medium-size antelopes, such as gazelle and impala, or smaller creatures. If they succeed in capturing one of the larger animals, it is likely they have selected a sick or lame animal, or a female in an advanced state of pregnancy.

Wild dogs cover a narrower range of prey species than any other major predator. In places of East Africa where the dogs have been studied, one-half to two-thirds of their diet consists of Thomson's gazelle, and the rest is comprised of wildebeest, topi, impala, and Grant's gazelle. Wild dogs also hunt an occasional reedbuck, bushbuck, or duiker. Further south in Africa, they make up almost nine-tenths of their diet with impala. There has been the odd instance of wild dogs killing an old lioness, and they occasionally take an ostrich, a sable antelope, a roan, or even an eland. Nevertheless their's is a restricted regimen. Leopards with their more variable hunting techniques account for twice as many different species.

A pack of wild dogs setting off across the savanna is one of the most memorable sights in Africa. But it is a sight that is becoming rare, and in many places, the dawnwatcher no longer can see the wild dogs loping through the dawnlight.

After the kill, three lionesses appear to usurp the carcass and their possession is undisputed by the dogs. One lioness, already full from a previous feed, soon lies down to rest. The others gorge themselves for an hour, then leave the remains to the hyenas, vultures, and jackals. By this time, the dog pack has begun the nine-mile journey back to the den. On the way, the dogs pass many zebra, but the indiscernible factor that triggers off the attack is missing. The hunt is over.

Rheas

by Donald F. Bruning

PART I: AT THE BRONX ZOO

I picked up the cream-colored rhea egg, nearly six inches long, and held it to my ear. The faint plaintive cry from within told me that the young chick would hatch within 24 hours. As I started to place the egg back into the incubator, a small piece of shell dropped onto my hand. The chick had "pipped" – making the first hole in the egg with its bill. An hour later, the chick again started to break the shell, enlarging the original hole so that a few large cracks began to radiate from it.

Three hours after the first hole appeared, the chick straightened out its legs, and the top popped off the shell. It was hard to believe, but the homely wet little creature that emerged would, if it survived, become an 80-pound, five-foot tall adult. Little did I realize as I watched the little striped chick that this was one of a long chain of events that would, less than three years later, take me to the pampas of Argentina.

The story started early in February 1968, at the Bronx Zoo. One of our Darwin's rheas *(Pterocnemia pennata)* had laid an egg in its outdoor enclosure. We took the egg inside, since we knew that it would freeze if left outside overnight, and it was placed in an incubator. Two days later, a second egg was laid, and within three weeks we had ten eggs in our incubator.

Rheas are large flightless birds found only in South America. The rhea sometimes is called the South American ostrich but really is not related closely to the true ostrich, although both birds have similar habits. Rheas are much smaller than ostriches; an adult rhea may stand five feet high and weigh 80 pounds, whereas an ostrich may grow to be eight feet high and weight over 300 pounds. The ostrich has only two toes on each foot, while the rhea has three.

Rheas are found in grassland or open brush country from eastern Brazil, through southern Peru and Bolivia, south to the Straits of Magellan. There are two species, each with three subspecies. The Darwin's rhea *(Pterocnemia pennata)* is the smaller species, with a shorter bill. It is brown in color, and its body and wing feathers are tipped with white. The larger gray, or common, rhea *(Rhea americana)* is basically gray in color, with very dark areas on the lower neck and chest.

The rheas in the past were hunted by the Indians and gauchos with bolas. Despite the hunting, rheas thrived until fences and large herds of cattle and sheep arrived on the scene. Today most rheas are prisoners on tracts of land bounded by stockmen's

The male rhea assumes all parental care of the young. He incubates the eggs and cares for the chicks after they hatch.

barbed wire. As the rural population grows, the land is divided into smaller pieces, and the great birds slowly are being exterminated. Even if the landowners do not kill them, the rheas, isolated on small plots of land, provide easy targets for hunters from urban areas.

During the spring of 1968 at the Bronx Zoo, we managed to hatch over 20 Darwin's rheas, 18 of which were raised. We were very pleased since only one other zoo in North America had ever hatched Darwin's rheas, but unfortunately had not been successful in rearing the chicks. In late April, our gray rheas also started laying eggs.

The two rhea species are quite distinct right from the egg. Gray rheas lay a cream-colored egg, while Darwin's rheas produce a green egg. Even though the color of both eggs fades out greatly during incubation and exposure to light, the eggs remain easily distinguishable. The chicks also are very different from one another. The Darwin's rhea has a much shorter bill and a more prominent striping of dark brown and white, while the gray rhea chick is striped with brown and gray. The legs of the gray rhea chick are longer than those of the Darwin's chick. Also, the gray rhea chick has bare legs, while the Darwin's legs have feathers over one half of their length.

By late May, when our Darwin's chicks were growing rapidly, the first gray rhea eggs were starting to hatch, and by the end of the summer we had managed to raise 20 gray rheas. Meanwhile, I had begun studying both species of rheas as part of my research for a Ph.D. thesis.

When the Darwin's rheas started laying eggs in early February of the next year, I weighed and measured each egg periodically from the time it was laid to the time that it hatched. At the same time, I spent many cold hours observing the adults in their outdoor enclosures. After hatching, the young Darwin's rheas began eating very quickly and they grew rapidly. At about 12 to 16 days of age, the young birds began to show a weakness in the tarsus, the lower section of the leg. However, a boost in the chicks' intake of calcium and vitamin D_3 solved the problem. Meanwhile, the gray rheas had begun lay-

Gray rhea chicks are striped with brown and gray. As adults, they will be basically gray in color, with darker areas on the lower neck and chest.

An adult male rhea is very billigerent and will attack anything that approaches the nest or the chicks.

ing eggs again.

Our rhea collection was growing rapidly until one June morning when disaster struck. I entered the park and, as was my usual custom, drove down to the rhea yard. The scene that I found was one of carnage. All six of our breeders in the Darwin's rhea enclosure were dead or dying. The keeper returned at this point with a large stick in his hand. He told me that as he arrived for work he had seen three dogs driving the adult rheas into the fences of their enclosure. He had chased the dogs away, but the damage already had been done. We worked frantically to save two of the birds that were still alive, but to no avail; they both died within a few days. To increase protection for the birds, a double fence enclosing a heavily planted area was erected around the rhea yard.

By this time, the gray rheas had produced over 60 eggs. The rhea nest is a depression scraped in the ground by the male. The male rhea builds the nest, incubates the eggs, and cares for the young. The female's only parental function is to lay the eggs. Such a reversed sexual role occurs in less than five percent of the known species of birds and very little is known about it.

Once the male has built his nest, the females

carefully approach it to lay their eggs. A group of females will lay eggs in one nest for a male until he has from 20 to 60 eggs and is busy incubating them. Then the females move on to another male at another nest and the process is repeated. A single female can lay 20 to 30 eggs. Since we only had two males and six females, we had to remove many of the eggs to an artificial incubator.

The male is very aggressive unless the female approaches the nest in the proper way. If she does not follow the proper procedure, she is likely to be struck by the male's bill. Once at the nest, she sits down on her heels and deposits her egg beside the male. The male immediately rolls the egg into the nest with his bill, and the female stands up and walks away.

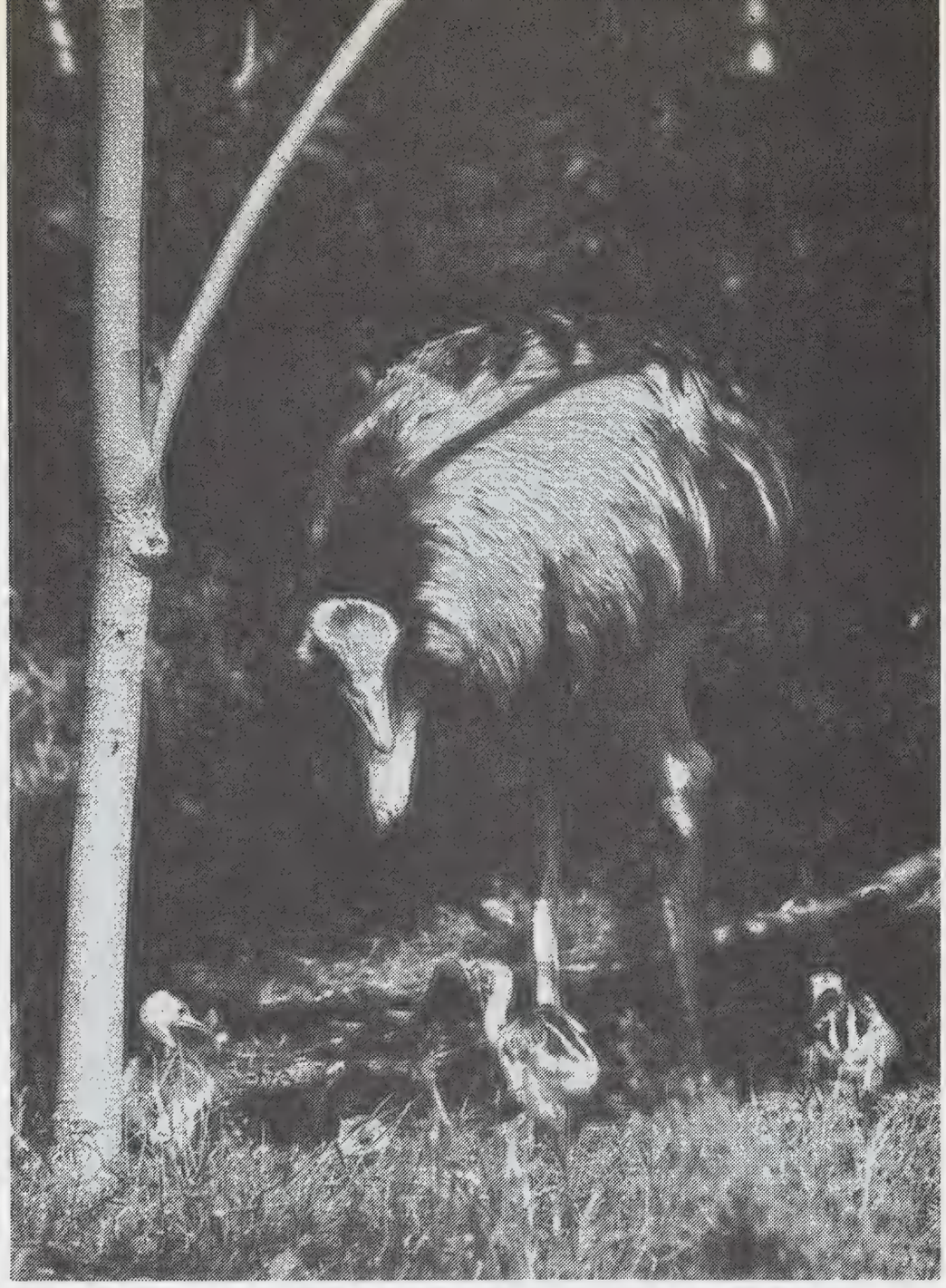
This egg-rolling behavior of the male is very interesting. We conducted experiments to determine the stimulus necessary for this behavior, and found that a male would travel up to 60 feet from the nest to roll an egg back into it. The only limitation on distance seems to be visual. If the male cannot see the egg while sitting on the nest, he will make no attempt to roll it back.

The females and young birds also will roll eggs if they have the chance. Whenever the male leaves the nest to feed or to drink, the females, seeing the uncovered eggs, go to the nest and try to roll the eggs out of it. Luckily for the male and the eggs, the nest is usually a few inches in depth, making it difficult to dislodge the eggs. When the male returns, he must return any loose eggs to the nest before he can continue incubation. A particular female will return at almost exactly the same time every other day to lay her egg. The timing of some females' egg-laying is so accurate that we could predict, within 15 minutes, when one particular female would approach the nest to lay her egg.

Once the young have hatched under the male, he stands up and slowly leaves the nest with the young following behind him. He leads the young around, but they must feed themselves. The male broods the young whenever it rains and each evening, but the young are largely on their own after a few days. The male aggressively protects the young during this period, and attacks almost any creature that approaches them.

Our male gray rhea hatched nine young out of a dozen eggs. At the same time, rhea eggs that we had put in our electric incubator started to hatch. Now we had the perfect opportunity to compare our rearing techniques with those of the male. The young rheas with the male were very active and spent most of the day chasing flies and other insects in the yard. However, these chicks did not eat the greens and poultry pellets we prepared for them and

The male gray rhea, shown with chicks, has a booming call. The chicks make shrill, peeping noises.



A gray male rhea shown here leads the young chicks around the yard. The chicks feed themselves and are largely on their own, but the male broods them at night and when it rains.

as a result had growth problems. Some developed leg deformities similar to those that occurred in our hand-raised young the year before. Finally we were forced to place half of the naturally-hatched chicks inside with their incubator-hatched kin. Here they quickly learned to eat greens and pellets, and within a week we were able to put them back out with the male and bring in the rest of his young for the same treatment.

We had raised 11 Darwin's rheas and 18 gray rheas by the fall of 1969, and had learned much about how to care for them. However, in 1970 new problems arose. We had two adult gray rhea males, (as well as one young male that was not of breeding age) with our group of females.

At first our old adult male dominated the other males and drove them away. When the old male built his nest and started incubating the first 15 eggs placed there, he allowed the young adult male to move about freely. The young male tried building nests in several different places, but all the females continued to lay eggs near the old male. Finally the young male built a nest about four feet from the old male's nest.

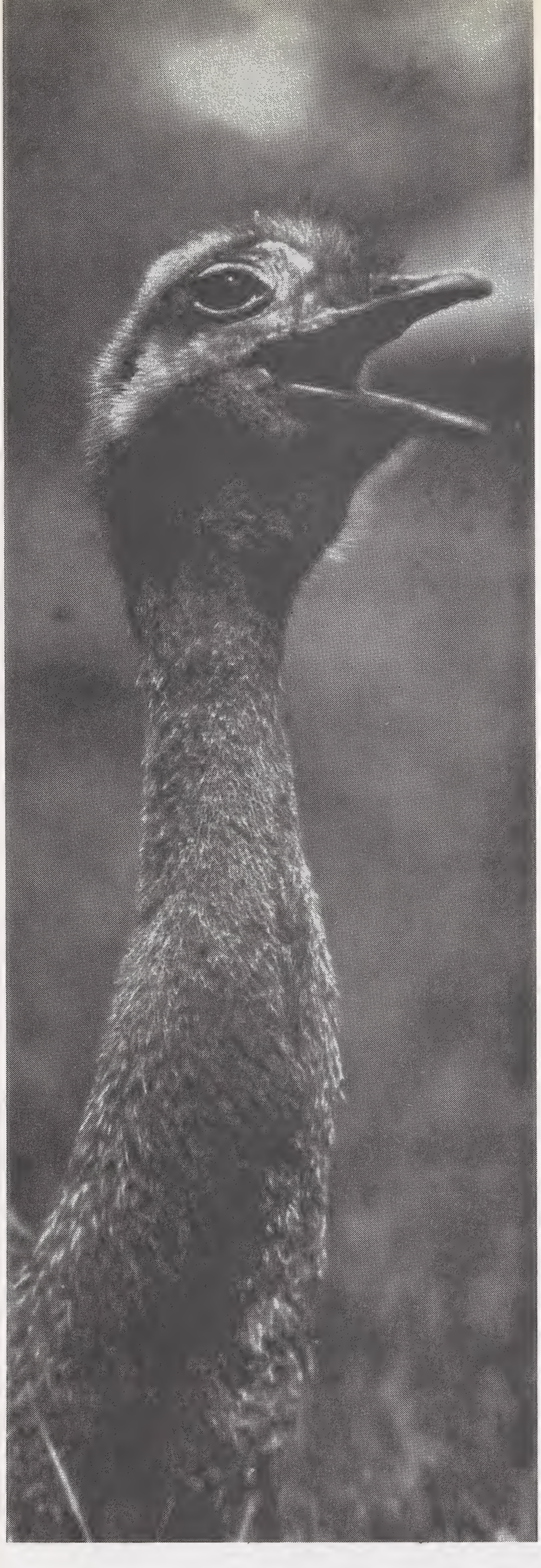
Interestingly enough, the old male would not chase the young male unless both males were standing, or unless the young male directly approached the old male's nest. Apparently, by acting submissively, in the fashion of a female, the young male could approach his own nest while receiving only threats from the dominant male. Once both males were on their own nests, there seemed to be no threats or any belligerence from either. However, when the old male left his nest to feed, the young proceeded to roll as many eggs as possible into his own nest. On returning, the old male would settle down on the few eggs remaining in his possession. But when the young male in turn would leave his nest, the old male would repossess all the stolen eggs. We knew that the eggs could not tolerate this treatment for very long, and had just decided on a method for solving the problem, when the old male solved it for us.

He simply left his nest and built a new one on the other side of the enclosure, drawing the females to this new site. The old male's action left his younger competitor in confusion. He could not decide whether to stay with his own nest or take over the one abandoned by the older male. He began to roll eggs from one nest to the other. Finally, we took all but four eggs from him. When, after a few days, he settled down to incubating these eggs, we returned the others to him.

The eggs now being incubated by the young male were the first group to be laid and therefore the first to hatch. However, only five of a clutch of 14 eggs produced chicks. After the chicks hatched, the young male did not seem to know what to do with them. When one chick tumbled out from under the male's wing, he struck it with his bill and bruised the side of the chick's head. The injured chick had to be treated for the bruises.

Finally when the chicks were less than two days old, the male walked away and made no effort to call them. The chicks wandered about the yard for some time before they found a "father" that would accept them; it was the old male. The chicks crawled under his wings and were right at home for the night.

Early the next morning, I waited at the rhea yard because I knew that a male rhea usually continues incubating his eggs for about 24 hours after the first chicks hatch. The old male could easily consider the adopted chicks his own and abandon his nest with its still unhatched eggs to care for the chicks. As soon as the chicks tumbled out, I caught them and took them back to the young male's nest. The young male now seemed to accept the chicks and even led them around the enclosure that morning; however, in the late afternoon, when he should have settled down to brood the chicks for the night, he again seemed completely oblivious to them.



Once again the chicks found the old male and crawled under his wings for the night. This entire procedure continued for three days. Each day the young male spent more time with the chicks, but eventually abandoned them each evening. On the morning of the fourth day, the inevitable happened. The old male left his nest to care for the chicks. I was sure that this would spell the end of his own eggs, unless they were taken to our artificial incubator. Unfortunately, the incubator was nearly full of eggs and I was able to make room for less than half of his 20 eggs.

Luckily it was a warm day and the old male returned to his nest with the adopted chicks early that evening. The next morning the male was up early with the chicks, and I gave up hope for his remaining eggs, which were due to hatch the following day. It was hot that afternoon when I finally returned to check on the young chicks. To my amazement, there seemed to be one extra chick with the male. Not believing my eyes, I opened the gate and went into the yard. There on the nest was the open shell from which the chick had hatched. But that wasn't all — three other chicks seemed to be in the process of hatching. Unfortunately, only one of the three managed to hatch successfully, but that alone was a spectacular feat, since the eggs had been abandoned over 36 hours earlier.

From all of these experiences, we had learned a great deal about rheas and how to rear their chicks. The next step was to visit Argentina and see if what we had learned at the zoo would also hold true for birds roaming freely on the pampas.

(Part II will be published in a later issue)

An adult Darwin's rhea standing five feet high and weighing 80 pounds (at left) begins life as a brown-and-white striped chick (see page 25).

animal kingdom REPORTS

KOMODO MONITOR – A PREDATOR

Evidence secured by Dr. Walter Auffenburg, research associate in herpetology of the New York Zoological Society, during his third expedition to the native haunts of the Komodo monitor confirms earlier observations that the giant lizard is a fierce predator, capable of downing large animals.

Dr. Auffenburg, of the Florida State Museum, reports that the monitors on the island of Flores, in Indonesia, raid farms and regularly kill domestic livestock such as goats, pigs, and buffalo. The scientist, whose work on the monitor was initiated by the Charlotte Ordway Fondaras Wildlife Protection Fund of the zoological society, also met island residents who have been attacked and injured by the giant lizards, which are the world's largest.

Ever since the first scientific observations of the lizards were made earlier in this century, researchers have questioned whether the animal is primarily a predator or a scavenger. Dr. Auffenberg, on two visits to the island of Komodo and a recent visit to Flores, 20 miles from Komodo, has amassed considerable evidence that the monitors are indeed predators, as was propounded by observers on some of the first expeditions to the island.

The monitor's feeding habits first were reported in depth by W. Douglas Burden, a former trustee of the zoological society, who headed an expedition to Komodo in 1926. He brought back to the Bronx Zoo the first two Komodo monitors ever exhibited in the United States. The Komodo monitor, can grow to a length of more than 10 feet and a weight of 250 pounds. It inhabits the islands of Rintja and Padar, as well as nearby Komodo and Flores.

During his stay this summer on Flores, Dr. Auffenberg studied the relationship between the Komodo monitor and the smaller, slimmer water monitor, which also inhabits the islands.

COMMUNITY AFFAIRS OFFICER APPOINTED FOR BRONX ZOO

Herbert J. Knobloch, long-time curator of education of the New York Zoological Society, has been assigned additional duties as community affairs officer of the Bronx Zoo. Mr. Knobloch will coordinate projects with the director, with the department of education, and with the department of publications and public relations in community relations. He will undertake specific community environmental science projects and work with the society's public relations staff on community programs.

Mr. Knobloch is a graduate of New York University and holds a B.A. in biology. He graduated from Evander Childs High School and was given the school's "distinguished alumnus" award. An officer of the 52nd Precinct Community Council, Mr. Knobloch also is a member of the Bronx Historical Society. Married, with two children, Mr. Knobloch lives in the Woodlawn section of the Bronx.

HOW-TO BOOK ON ENVIRONMENT EXHIBITS PUBLISHED

A major work on how museums, zoos, and aquariums can center exhibits and educational programs on the environment has been published by the American Association of Museums. Dr. James A. Oliver, director of the New York Aquarium, served as chairman of the association's environmental committee, which prepared the book. Dr. Oliver coordinated preparation of materials, from dozens of sources, that were utilized in the publication.

The book begins with a section of background on how man affects the environment, discussing the chain of life, resources, and the interrelationships of species. Other chapters deal with population, pollu-

tion, and various exhibit techniques, in addition to programs of environmental action.

The book discusses various environmental concepts and describes exhibits and projects that illustrate them. William G. Conway, general director of the New York Zoological Society, has written the section in the book on "The Role of Zoos and Aquaria in Environmental Education."

Essentially the book offers a guide to a wide spectrum of institutions, from suburban nature centers to major museums and urban neighborhood centers, on how to develop meaningful environmental education programs.

Perhaps the key to the philosophy presented in the book is a quote from the society's chairman of the board, Laurance S. Rockefeller, which is contained in the opening of the publication: "The end of our world could be neither by a bang nor a whimper. We could simply smother in the wastes of our own affluences."

THE bookshelf

THE LAST DAYS OF MANKIND. *By Samuel Mines. Simon and Schuster, New York, 1971. $7.95.*

Samuel Mines, for years a public relations official for a major pharmaceutical and chemical company, has a budding side career, that of a writer on the environment. Mines, long a weekend environmentalist, has established himself as a regular contributor to one of the newer ecology periodicals, and now has a whale of a book to his credit.

He began work on *The Last Days of Mankind* five years ago. It is one of those rare books picked up by the publisher when the author was sight unseen.

Mines' writing is lively and often his style hits hard at those he accuses of responsibility for our environmental crisis. In this book he covers all the bases. Mines accurately, indeed, sometimes surgically, dissects the complicated business, politics, and science of ecology. Some of his public relations colleagues in industry and government will not like Mines' book, for he pulls no punches. Mines takes sharp aim on a number of government agencies and corporations – and what he says is calculated to make his readers angry at governmental blundering and the disregard of public good displayed by some quarters of the business establishment.

Mines tells of the rape of South Florida and of the attempted rape of the California redwoods. He examines pesticides and pollution, and the ecology of the city – a critical part of the crisis that middle-class conservationists often disregard in their efforts to keep the suburbs green.

The book opens with a discussion of the concept of ecology that is the most understandable that this reviewer has ever read. This introduction is worth the price of the book.

Mines' weakest chapter, that on endangered wildlife, is so largely because of overgeneralization. However, a weak chapter in this book likely would be considered a good one in many others on the subject. The author is a little careless in bestowing occupational titles upon individuals active in the conservation movement, but it really doesn't detract from the book.

The only hope Mines holds for man's survival is the possibility that we may develop a "politics of ecology" in which each act is considered in an ecological context, and a land ethic – a philosophy that the land, no matter who owns it, really belongs to all the people.

E.R.R.

ABOUT THE AUTHORS

Joseph Bell, a long-time friend and associate of Lloyd Sandford, is associate curator of ornithology at the Bronx Zoo. **Donald F. Bruning** is the zoo's assistant curator of birds. **Edward Edelson** is a science writer who often contributes to *Animal Kingdom.* **U. Erich Friese,** formerly assistant curator of the New York Aquarium, is the curator of fishes at the Taronga Zoological Gardens Aquarium in Sydney, Australia. **Norman Myers** has spent considerable time studying East African wildlife.

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Design by Peter Oldenburg

dying species . . .

"The beauty and genius of a work of art may be reconceived though its first material expression be destroyed; a vanished harmony may yet again inspire the composer; but when the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can be again."

William Beebe
First curator of birds, Bronx Zoo

COAHUILAN BOX TURTLE
Terrapene coahuila

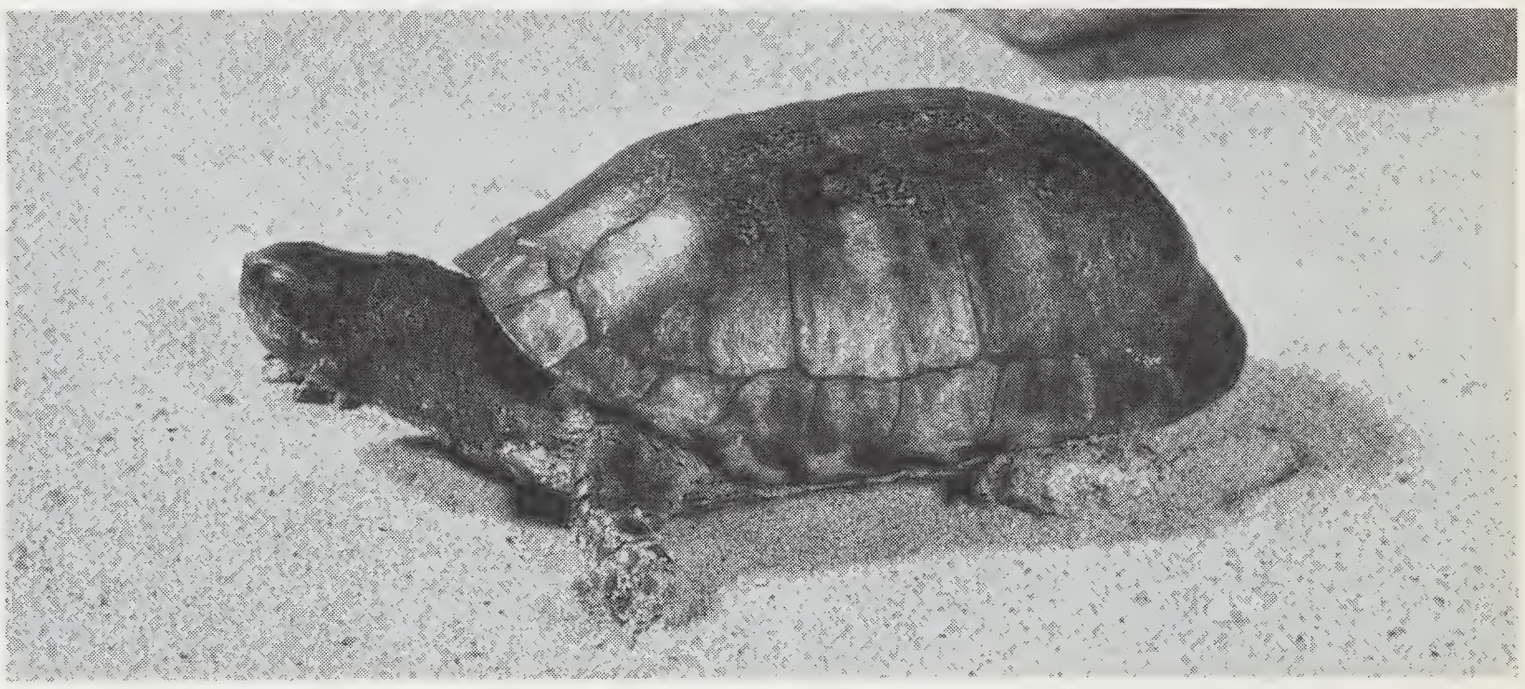
During the late 1930s, Ernest Marsh made a series of collecting trips to the central region of the Mexican state of Coahuila. His quest for unusual animal and plant specimens led him to the intermontane basin of Cuatro Cienegas.

For the most part, Marsh found the region rather inhospitable and, superficially at least, like the other Chihuahuan Desert localities he had investigated. The climate was arid, and mesquite, cacti, and creosote bush were the dominant vegetation. However, Marsh discovered the basin also contained a permanent supply of water in its scattered ponds, springs, marshes, and streams. His search of these aquatic habitats proved fruitful; among the varied forms of wildlife he found a dark-colored turtle species that was known only to residents of the basin, who called the reptile "tortuga negra."

Marsh returned to the United States and deposited his collection of amphibians, reptiles, birds, mammals, and plants in Chicago's Field Museum of Natural History. During the next few years, biologists examined and classified his specimens. Finally, in 1944, the "tortuga negra" was introduced to the biological science community as *Terrapene coahuila* – the Coahuilan or water box turtle.

This turtle's habits differ from the terrestrial nature of other box turtles. Biologists who have ventured to the water box turtle's habitat have been impressed with its aquatic existence. Apparently, the strong climatic pressure of countless millenia have forced this species to modify its appearance in its adaptation to aquatic life. The Coahuilan turtle has lost the striking coloration so typical of many other members of its genus. Of greater significance, this species possesses conspicuous webs between the toes of its hind legs and has developed the flattest shell of living box turtles. Unquestionably this streamlining process has permitted greater agility and has allowed the water box turtle to exploit its aquatic environment.

Although a number of biologists have sought additional localities for *Terrapene coahuila,* they have failed to extend the species' geographical range beyond that from which it was originally described. It has been calculated that existing populations of water box turtles live within an area which does not exceed 300 square miles, and there, only in scattered marshland pockets of Cuatro Cienegas.



Possibly, the Coahuila species evolved from one of the southern forms of the eastern box turtle which inhabited the Chihuahuan Desert in earlier times. Apparently, the turtle population was divided as the western deserts began to form. Then, as the region became increasingly arid, the bulk of the population retreated eastward and left a relict population trapped in the Cuatro Cienegas basin.

The water box turtle's day begins at dawn. Patrolling the grassy shallows or the heavily vegetated margins of a pond or marsh, it searches out edible plants or the remains of small animals. Feeding activity presumably ceases during the heat of the day and the turtle retires into the soft mud at the bottom of its aquatic retreat. As dusk approaches the turtle briefly returns to its feeding schedule.

In September, the species begins its lengthy breeding season which peaks the following March and April and tapers off in the late spring months. A half dozen eggs are deposited and after several months of incubation, the hatchlings emerge from their earthen nest. The juveniles possess a contrasting yellow and black reticulated or radiated pattern on their shells. As the young assume their adult roles, the carapace darkens and the pattern becomes obscured.

The status of the water box turtle is of concern to conservationists and herpetologists. Certainly its tiny distribution and restricted habitat weigh heavily against its continued survival. In recent years the construction of irrigation canals and agrarian developments have altered portions of the box turtle's habitat. The effects of these modifications are not yet fully known. In recognition of the precarious position of this species, *Terrapene coahuila* has been placed on the IUCN's list of rare and endangered species.

A number of protective measures have been proposed. Unquestionably the transformation of parts of Cuatro Cienegas into a national park and the restriction of draining activities would help preserve the ecology of the water box turtle's environment. Unfortunately, these proposals have not been realized.

Today, more than 100 specimens of *Terrapene coahuila* are preserved in scientific collections. Hundreds more have been removed from the basin by amateur and commercial collectors. The burden that the water box turtle has had to bear has been heavy. With adequate preserved materials available, it is hoped that investigators will refrain from removing additional members of the species.

JOHN L. BEHLER

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MAGAZINE OF THE NEW YORK ZOOLOGICAL SOCIETY VOL. LXXIV, NO. 6 DECEMBER, 1971

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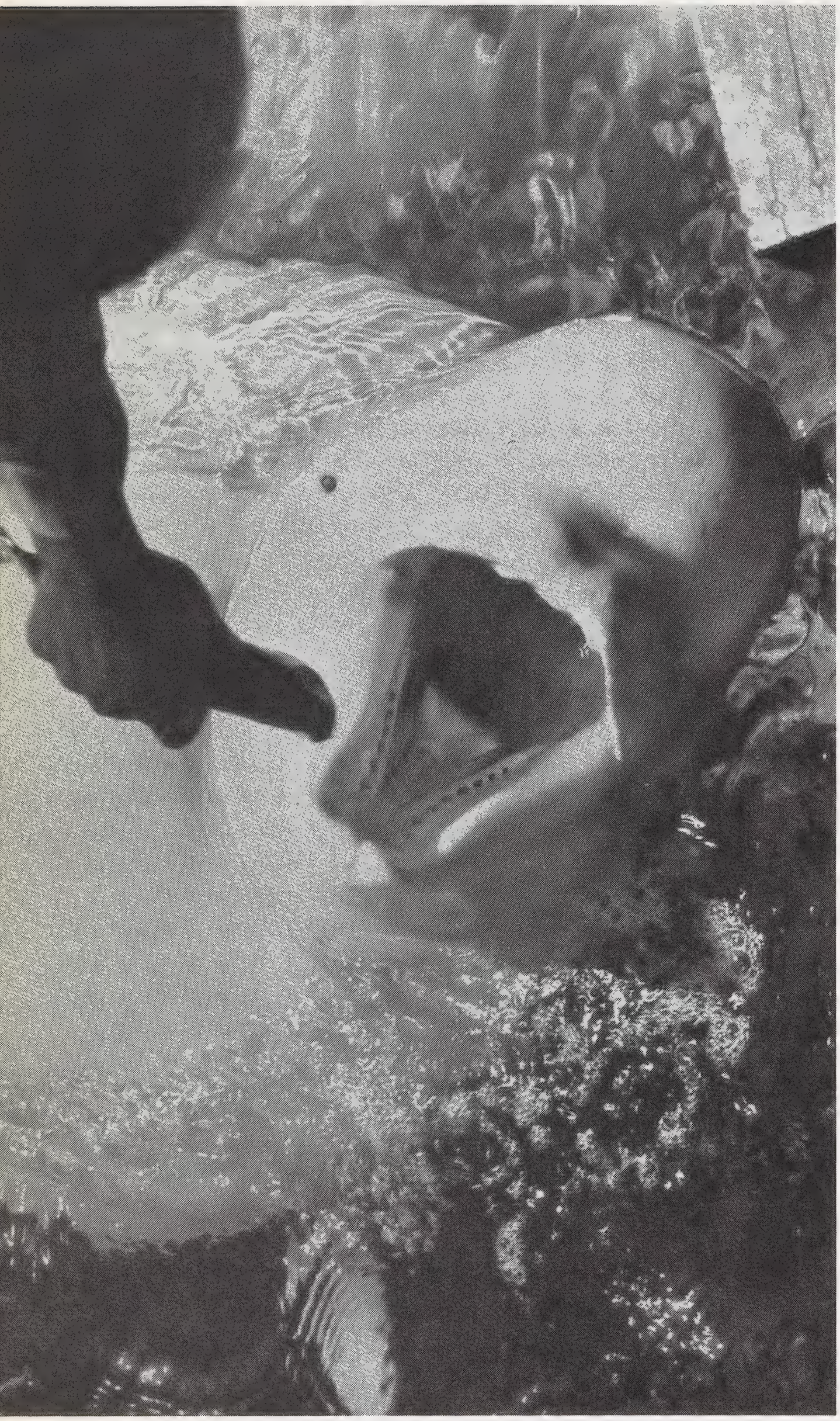


"Talking" Through the Nose

Sound Communication in Whales and Dolphins

by Myron Jacobs

A beluga, or white whale, at the New York Aquarium, opens its mouth to feed, not to "talk." But whales and dolphins do communicate by a profusion of sounds and "songs" that are being studied both in aquariums and in the wild.

Among the questions most frequently asked about the whales and dolphins on exhibit at the New York Aquarium is whether or not these large-brained, air-breathing mammals possess a language of their own. This intriguing question never has been answered fully. However, if the term "language" is used in its ordinary sense to include an orderly combination of words and phrases, each with a specific meaning, then as far as anyone knows, cetaceans have none. In this sense, language lies strictly within the province of human interactions and comprises the exchange of word symbols created by man as an audible or visible code expressing the meaning of the tangible objects as well as abstract concepts of his environment.

Human languages, however, represent only one of many means by which members of any particular group communicate. The others include non-articulated sounds, body movements executed either alone or in combination with sound, bodily contact, and the exchange of chemical signals, especially involving the senses of smell and taste. Although all species of whales and dolphins – collectively, the order Cetacea – appear to use all of these mechanisms to communicate with one another, they have developed special abilities in the area of non-articulated sound communication.

It has been known for some years that many of the smaller dolphin species are capable of generating a wide variety of sonic and ultrasonic emissions, including squawks, whistles, and creaking sounds. Some of these sounds seem to be used as a type of "sonar" – or echolocation – which helps the dolphin navigate. Most of this repertory appears to be based on timed and phased combinations of a basic sound commonly referred to as the "click" or "pop." It has a fleeting duration of from one-thousandth to twenty-five-thousandths of a second and varies in intensity. A series of these sounds might be compared to the rapid staccato sequence of sharp sounds made when a wooden ruler is run across the slats of a picket fence. The frequencies of such sounds emitted by the bottlenose dolphin reach 150 kilocycles per second, which means that most of their range exceeds the 20 kilocycles per second upper limit of sounds audible to the human ear.

Because of the isolation of cetaceans in the uniquely-propertied aquatic environment, and their separation from terrestrial lines of mammalian evolution for approximately 50 million years, the body structure and behavior of whales and dolphins have undergone many significant changes. There is little doubt in this connection that the great variety of cetacean sounds, especially those made by the smaller species, are related to specialized structural modifications in the head and neck that evolved during this long period of adaptation.

The nasal passageways of cetaceans have been modified so they open at the top of the head as the blowhole, rather than at the front of the face. The location of the external nasal openings atop the body is a decidedly advantageous adaptation for an air-breathing animal that lives in the water.

Numerous sites for cetacean sound generation have been suggested. These include the larynx, blowhole, and a number of tubular structures leading off from the nasal passageways. The mechanisms

Dr. Myron Jacobs (right) is shown with an assistant in the Cetacean Brain Laboratory at the Osborn Laboratories of Marine Sciences, which is operated by the New York Zoological Society.

underlying the wide variety of sounds produced by cetaceans are poorly understood. The cetacean larynx cannot be considered a voice box, since generally it is devoid of vocal cords and has a smooth internal surface that seems incapable of much vibration. Instead, the structure of the larynx reflects an adaptation that supports respiration in the water. In fact, the cetacean larynx really serves as a modified segment of the respiratory tract that fits into the back of the nasal passageways and links them with the trachea and lungs. This adaptation effectively separates the respiratory path from the digestive tract and prevents the animal from choking on food when it is feeding under water.

Rather than in the larynx, the sound-making apparatus appears to be located primarily near the nasal passageways deep under the blowhole. Our

studies at the Osborn Laboratories of Marine Sciences indicate that the sophisticated patterns of sound emitted by dolphins and whales are based upon a complex control by the large brains of these animals. Only such a neural control can adequately account for the ability of dolphins to emit simultaneously two independent and quite different sound signals, such as a creaking noise and a squeal. Likewise, the intricate construction of the beautiful songs produced by the humpback whale can be accounted for only by a high level of control on the part of the brain. However, in order to appreciate this interpretation of the sound-generating mechanisms and some of the factors involved in their control, it is necessary first to have a little background information concerning the general structure of the nasal passageways of cetaceans.

The vertically-oriented nose of most cetacean species is comprised of a more superficial, upper soft segment near the blowhole, and of a deeper portion supported by bone near the nasopharynx and larynx. A series of distensible air sacs, which vary in number and length according to the species, extend from the nasal passageways. In the bottlenose dolphin there are three such pairs of sacs, one pair just under the blowhole and two other pairs branching off the nasal passages. These nasal sacs extend from the nasal cavities into the soft tissues in front of and around the nose. It seems likely that they act as reservoirs for air that either is inspired when the animal surfaces to breathe, or is transferred to these sacs from the lungs or from other segments of the respiratory tract while the animal is submerged.

The size of the openings of the sacs into the nasal passageways appears to be regulated by pressure of the lips of each opening against nearby muscular or bony structures. It is felt that the sacs play an important role in the emission of sounds by cetaceans.

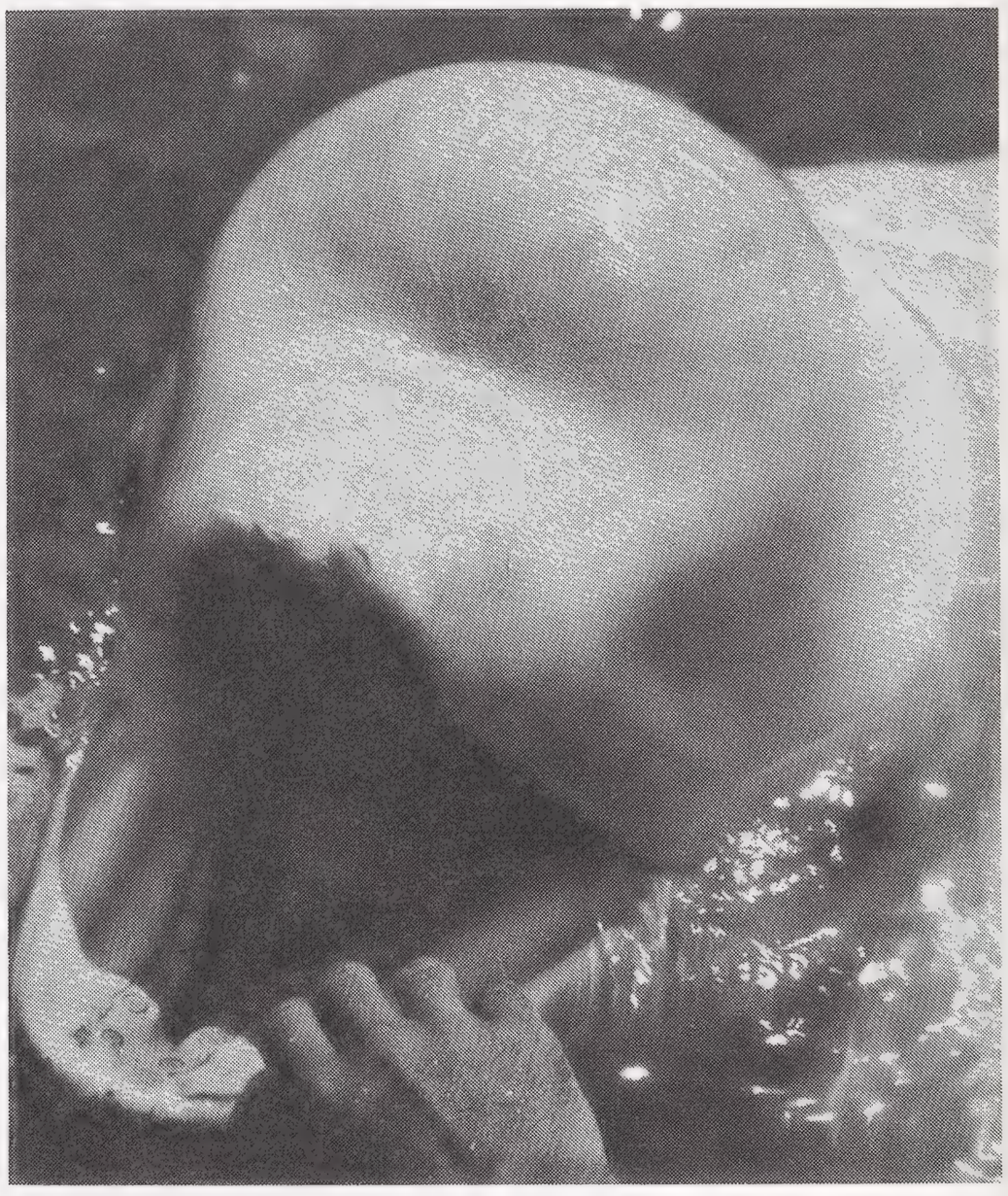
This theory is based on the presence in the sac walls of sleeves of voluntary muscle fibers supplied by the facial nerve. The latter nerve, the main motor supply to the face of all mammals, may play the key role in controlling production of the sounds of whales and dolphins by bringing about contraction of the sac walls.

In cetaceans, the innervation pattern of the facial nerve to these sac muscles and to other muscles of the face and forehead region differs greatly from the typical distribution of the same nerve in other mammals. Therefore, a brief explanation of these important differences is warranted here.

During vertebrate evolution, the muscle masses supplied by the facial nerve have migrated from the neck region to the face. In fish these muscles fulfill the vital mission of constricting the gill arches, enabling respiration. Mammals, however, have gill arches only as transitory structures, present during embryonic life. Most of the undifferentiated muscle tissue of the vanished gill arches migrates into the facial region, where in higher mammals and man it gives rise chiefly to the muscles of facial expression.

Whales and dolphins, as mammals, possess embryonic gill arches, but the primitive muscle tissue associated with them differentiates into a facial musculature that serves entirely different functions from those carried on by the facial muscles of other mammals.

The individual small muscles which enable man to smile, grimace, raise the eyebrows, and wrinkle



the forehead have fused in cetaceans into a large, multilayered muscle sheet called the maxillonasolabial muscle. Because of modifications that have occurred in the shape of the facial bones and in the attachments of this muscle during the evolution of whales and dolphins, the maxillonasolabial muscle is quite incapable of producing in these animals any of the movements associated with facial expression. This can be appreciated by considering the face of the bottlenose dolphin, which in Mona-Lisa fashion is frozen permanently into what appears to be a half-smile.

The maxillonasolabial muscle in cetaceans functions in a way appropriate for life in the water. Because of its attachment to soft structures in the forehead and nasal regions, this muscle has at least

Ethel, one of the belugas at the New York Aquarium, is shown above at rest. The bulbous prominence atop the head and overlying the mouth is known as the "melon" and figures in echolocational behavior.

Alex (at left), another of the aquariums's white whales, has thrust his melon forward as if attempting to sound on an object. The melon does not appear to be protruded as far forward during a feeding session as when the animal is actively echolocating underwater.

The Pacific white-sided dolphin (shown below, left and right) in the wild gathers in schools estimated to contain fifteen hundred individuals. Modifications in the attachments of the maxillonasolabial muscle and in the shape of the facial bones in cetaceans give their faces a perpetual smiling appearance.

three functions that relate to sound production and the manipulation of trapped air.

One of these functions, most important for cetacean survival, is the control of the blowhole opening. This is done by contraction of a group of maxillonasolabial fibers which are inserted in the blowhole margin. Contraction of these powerful muscle fibers results in opening of the blowhole by stretching the dense elastic core of the blowhole apparatus.

When these muscle fibers relax, the blowhole snaps shut as the pull exerted on the elastic tissue is released. The main task of the blowhole is enabling the cetacean to breathe, although it may also play a small role in making sounds as air is expelled. However, most of the sound emissions in cetaceans arise while the animals are submerged with the blowhole closed. Thus, the source and more fundamental

mechanism for producing sounds appear to lie deeper than the blowhole, in another region acted upon by the maxillonasolabial muscle.

A second group of maxillonasolabial fibers apparently is more closely related to the transmission of sounds used by dolphins during echolocational activity. These fibers are inserted into a fatty, compartmentalized structure in the forehead, in front of the blowhole, that is commonly referred to as the "melon."

The melon, which can be observed on the New York Aquarium's belugas, exists only in toothed Cetacea (suborder: Odontoceti). It was once thought to be a sense organ responsive to changes in water pressure. In more recent years, however, more and more evidence has accumulated to show that the melon is a critical part of these animals' echolocational system.

The melon directs sound waves, primarily rapid series of low frequency clicks, forward so that they can be beamed directionally off the forehead. The shape and position of the melon appear to be important factors in this function and may be influenced by the state of contraction of attaching maxillonasolabial fibers.

The actual generation of sounds in cetaceans, however, appears to involve a third functional group of the maxillonasolabial musculature lying deeper in the muscle. This musculature forms sleeves or sphincters of contractile tissue encircling the walls of the air-containing nasal sacs. When muscular contraction occurs, the pressure within the nasal sacs increases, forcing air to pass through the slit-like opening of the sac into the main nasal passageway and thereby giving rise to the production of a sound. This mechanism of sound production may be likened to stretching the lips of an inflated balloon to produce a squeal: the greater the tension, the higher the frequency of the sound emanating from the mouthpiece of the balloon.

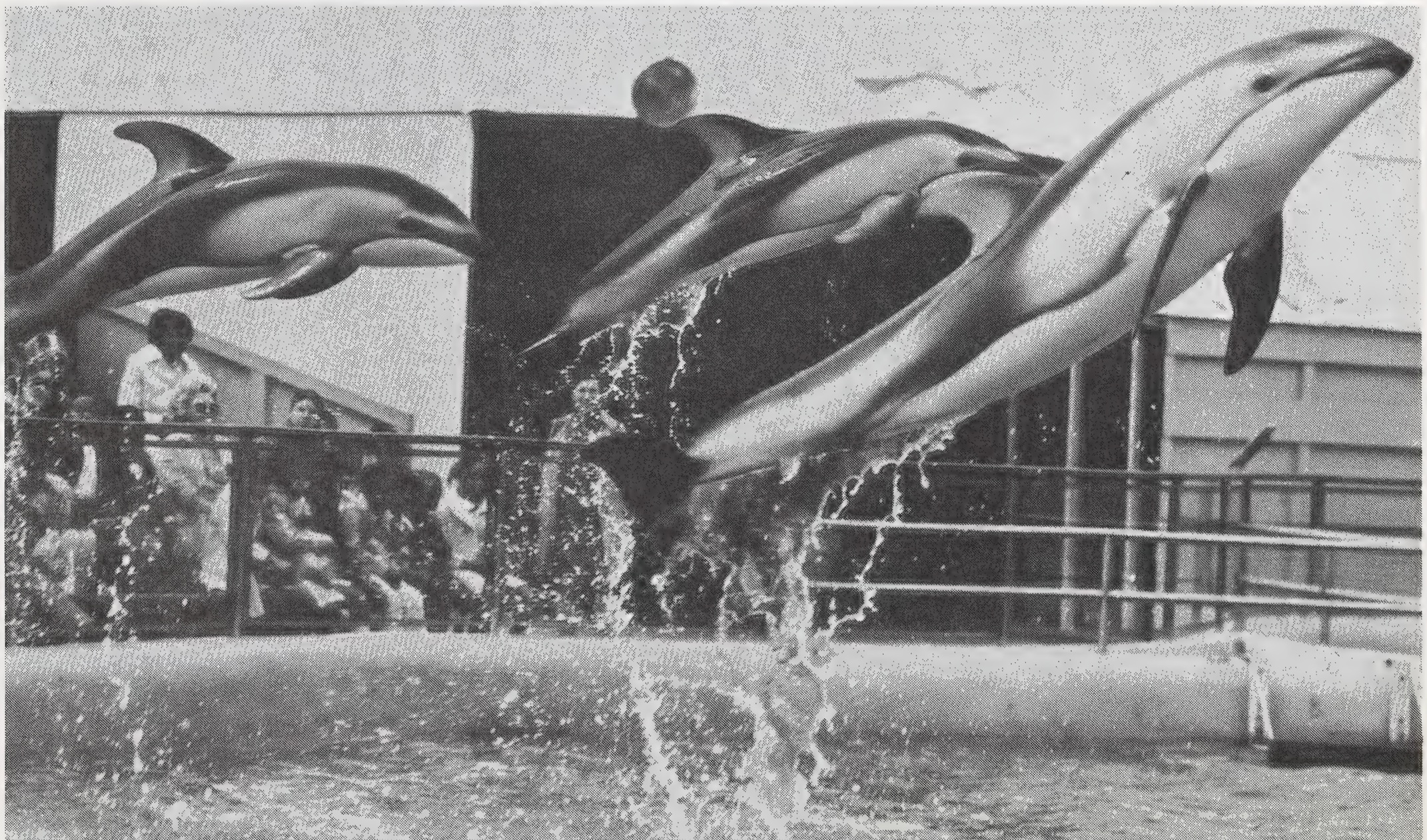
The nasal sac mechanism appears to be responsible for the majority of sonic and ultrasonic signals emitted by dolphins. Thus, the squeals and squawks of these animals are interpreted as extremely short bursts of air expelled at high pressure from the nasal sacs at such rapid rates that, to the human ear, they seem to fuse into one signal.

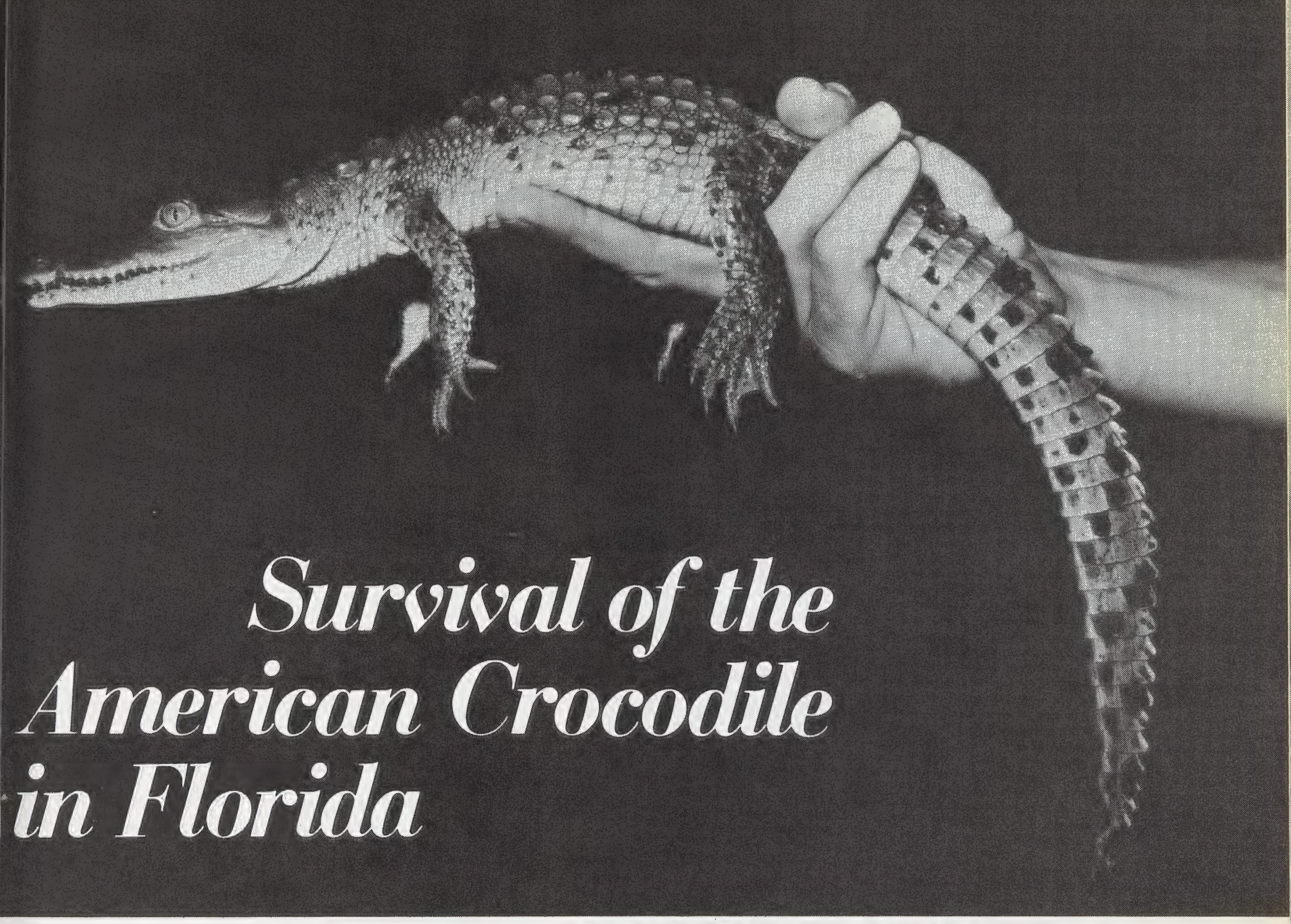
It is likely that similar mechanisms exist in the larger whales which form the functional basis, for example, of the protracted songs of the humpback whale. Such mechanisms in small and large cetaceans depend primarily on the richness of connections between the brain and peripheral sound-producing structures. There is justification for regarding the abundant and variable sounds produced by whales and dolphins as their major achievement in the sphere of expressive motor behavior. It is possible that just as man has learned to manipulate his environment by the use of his hands, so cetaceans appear to have learned to use their unusual sound-based communicative capabilities to dominate their world.

ACKNOWLEDGEMENT

The author's research on the neural basis of cetacean behavior is supported by Grant NS 06582 from the National Institute of Neurological Diseases and Stroke.

Three white-sided dolphins leap in unison upon command during the whale-dolphin training sessions at the New York Aquarium.





Survival of the American Crocodile in Florida

by John C. Ogden

The American crocodile *(Crocodylus acutus),* whose range extends northward from Colombia and Central America to the Keys and the southern tip of the Florida mainland, now is extremely rare in that state. Even in the past, however, when the crocodile was at least somewhat more common in Florida, little attention was paid to it.

"The crocodile is of no economic value and is chiefly interesting as a freak of geographical distribution," wrote Hugh M. Smith, United States Commissioner of Fish and Fisheries, in 1896, in his economic evaluation of Florida's Biscayne Bay. Smith's opinion of crocodiles certainly reflected the general lack of attention this reptile received in Florida in his day and, with few exceptions, has continued to receive to the present. Far less is known about the American crocodile that the American alligator, the only other crocodilian native to the United States. Our knowledge of the American crocodile's former range, abundance, and habits in Florida is sketchy, simply because so little past information is available for reconstructing the crocodile's history.

At the turn of this century, crocodiles could be found, although sparingly, in coastal estuaries along Florida's lower east coast. They ranged north to the Palm Beach area, and perhaps further north to the Indian River region of Brevard County, about 200 miles north of Miami, where C. J. Maynard killed a crocodile, 10 feet long, in 1872. However, during the 1890s, crocodiles apparently were most abundant in the area only a few miles south of Biscayne Bay and westward into eastern Florida Bay. Here the crocodiles inhabited shallow, mangrove-lined bays.

A. W. Dimock made several trips searching for crocodiles in Florida Bay and adjacent Barnes Sound between 1889 and 1906. He described an area only 10 miles long and three miles wide, primarily along the northeastern shore of the bay, as the region where crocodiles were most numerous. Although Dimock considered the crocodiles "plentiful" in this relatively small area, a close reading of his account gives one the impression that even here crocodiles were not truly abundant. For example, Dimock considered that being able to get close to

four crocodiles in one day was unusual enough to deserve special mention in his report.

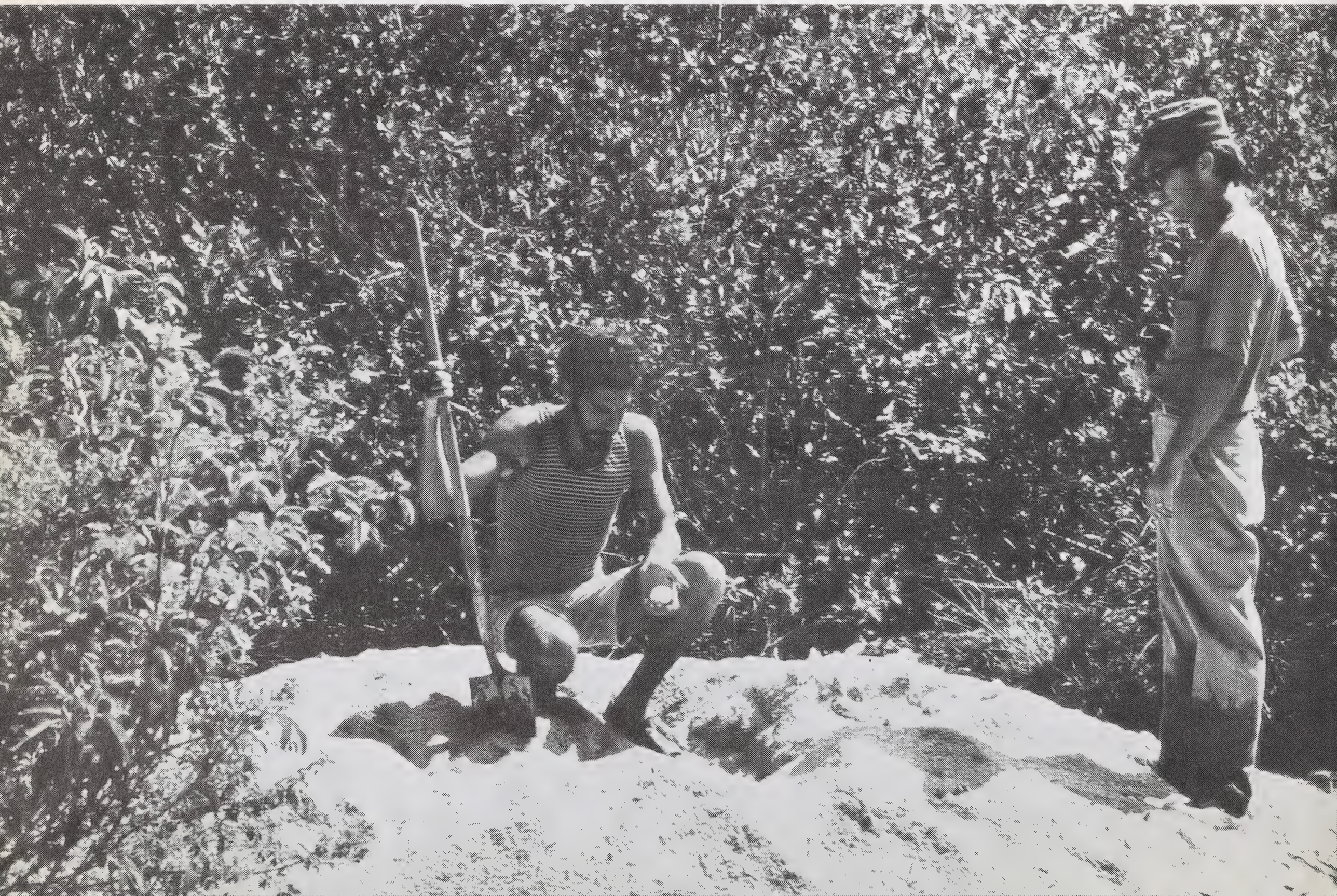
The remainder of the former range of the crocodile extended westward into the lower Florida Keys and into western portions of Florida Bay, perhaps as far as Cape Sable. There is no evidence that crocodiles nested in any portion of the west coast of the Florida peninsula, including seemingly favorable habitats in the mangrove wilderness of Ten Thousand Islands or along the labyrinth of mangrove-lined creeks and rivers on the southwest coast below Naples. Most of this mangrove region remains wilderness, in part preserved within Everglades National Park. Yet the total number of positive sightings of crocodiles on the southwestern coast of Florida can be counted on the fingers of one hand.

During the 1890s, the population of crocodiles in Florida likely remained near what it had been at the beginning of the 19th century. It must be remembered that southern Florida has been developed almost entirely within the present century. When Smith visited Biscayne Bay in 1895, the community of Coconut Grove was larger than nearby Miami, and in all of south Florida, only Key West had a human population over 10,000 people.

The greatest decline in numbers of crocodiles apparently occurred during the early decades of this century. By 1923, Thomas Barbour, director of the Museum of Comparative Zoology at Harvard, predicted that "the closing chapter will soon be written" on crocodiles in Florida. Yet crocodiles remained so common during the 1930s and 1940s that commercial fishermen felt it necessary to thin them out on occasion in certain portions of Florida Bay where the animals were accused of tearing fishing nets. By 1950, when Florida Bay became a part of Everglades National Park, the crocodile population in the bay had declined sharply. This was due to the toll taken by fishermen, the loss of habitat at the edge of the bay, and the collecting of young for the pet trade.

Protection of the bay by the National Park Service certainly slowed but did not stop the decline. An examination of unpublished Everglades National Park records since 1950 gives the impression that a slightly larger number of crocodiles inhabited Florida Bay during the early 1950s than today. Some killing of crocodiles must have continued even after the National Park Service acquired the bay. Meanwhile, the favorable habitat next to the bay on the rapidly developing upper Florida Keys continued to

Author John Ogden (at right) and another biologist examine an American crocodile sand nest after a successful hatch. An adult crocodile had opened the nest from the top to enable the hatchlings to escape.



be destroyed. By the late 1960s, even park rangers who patrolled the bay seldom if ever sighted crocodiles.

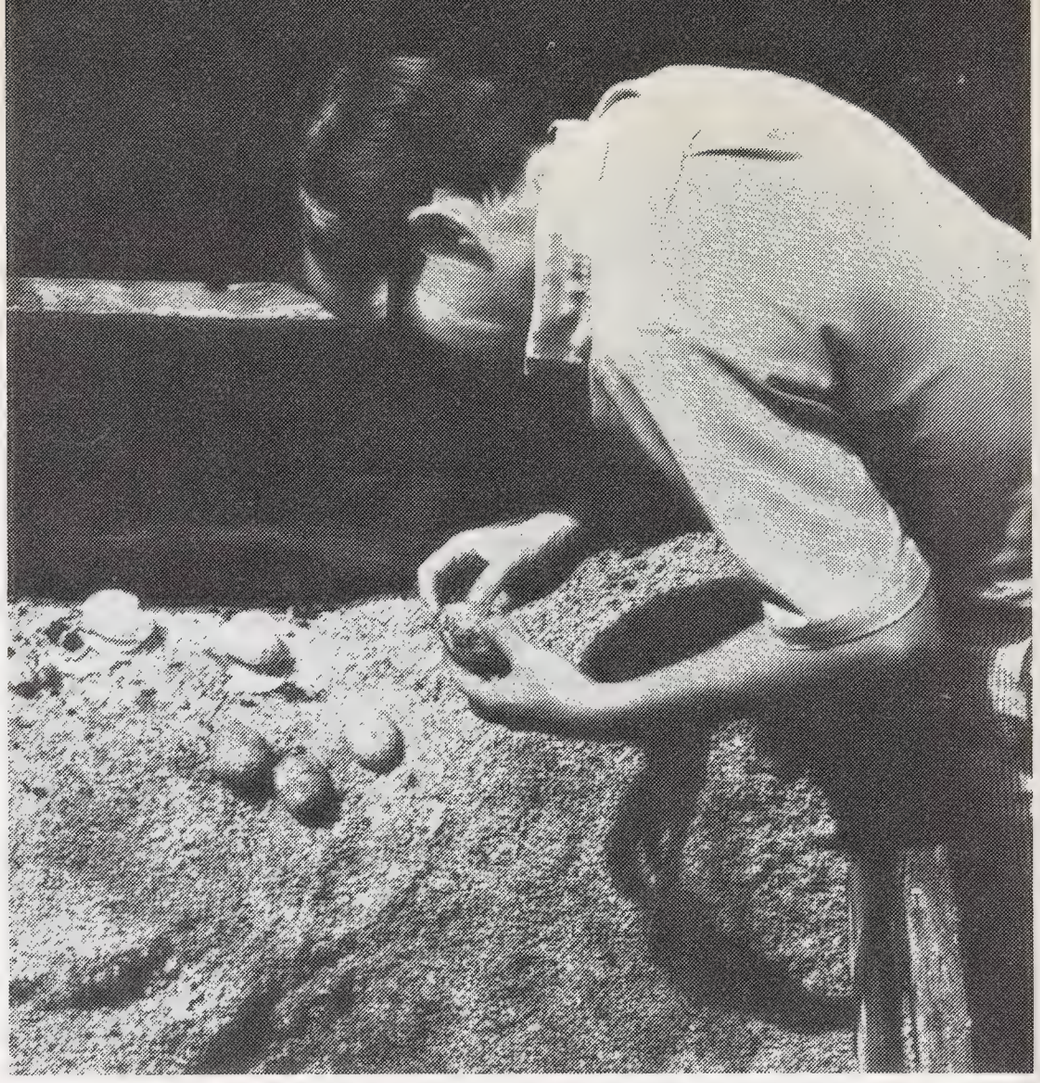
Crocodiles have now disappeared from the 200-mile lower east coast of Florida. The present population occurs almost entirely within Monroe County, Florida, from northern Key Largo south and west to the fringes of Plantation Key, through Card, Barnes, and Blackwater Sounds, and Lake Surprise, into eastern and north-central Florida Bay. A disjunct population, consisting of only a few crocodiles, exits in the lower Florida Keys near Big Pine Key. Within these two areas of approximately 300 square miles, fewer than 500 crocodiles, and more likely 200 to 400, exist at the beginning of each nesting season.

Responsibility for survival of wild crocodiles in Florida well may depend on protection given these animals in Florida Bay within the Everglades National Park, and in the vicinity of Big Pine Key on lands administered by the Bureau of Sport Fisheries and Wildlife as a National Wildlife Refuge. Outside of these federally administered areas, it seems unlikely that a viable crocodile population will survive the remaining decades of this century. Elsewhere in Florida, the crocodiles are in the path of ever-increasing human activities, including commercial and sports fishing, boating, and plans for industrial and residential development of the region from southern Biscayne Bay south to the upper Florida Keys.

The National Park Service has recognized the need for additional information on wild crocodiles as a prerequisite for proper management of their habitat and protection of the remaining population. In 1969, the author and Richard Klukas, both biologists, began a field study of crocodiles, with major attention given to the Florida Bay portion of their range. Through this still-continuing study we hope to determine the number and location of crocodile nests in Florida Bay, the animals' nesting success through three or more breeding seasons, and the factors that influence nesting success. In addition, we hope to develop a technique for hatching and rearing crocodiles in captivity as preparation for possible restocking projects. By studying earlier nesting records, mostly unpublished, we are trying to find if the crocodiles in Florida Bay are maintaining a stable population. We also are studying seasonal movements of crocodiles in the Bay, particularly the movements of hatchlings.

Eggs in nest mounds found in the wild were carefully counted to check for later hatching success.

Egg development was also observed in artificial nest boxes in the Everglades National Park.



A ten-month old crocodile in a rearing pen is already more than a handful and, for the moment, successfully evades capture for an examination.

During the summers of 1970 and 1971, we examined 10 nesting sites containing eggs. Eight of the sites were on Florida Bay and two were on northern Key Largo. Crocodiles in Florida Bay annually begin nest construction in March and often use certain sites for several successive years. Most nests are completed and contain eggs before mid-April. The nests are mounds of sand or marl, depending on their location, and vary considerably in size. Although we examined only a few nests, we believe that the typical nest is a low mound measuring five feet to seven feet in diameter and from one foot to two feet high at its center. Each active nest mound is at the hub of two or three troughs, which apparently are dug in the soil by the female as she lies head away from the nest and kicks sand and marl back over it with her rear legs.

Nest mounds are built at the head of small sand beaches, or on slightly elevated marl bands along narrow tidal creeks, often within or at the edge of thickets of broadleafed hammock vegetation. Crocodiles seem to nest rarely if at all on low-lying sites, such as mangrove thickets, which can be flooded.

In the field, we locate the nests by slowly patroling the waterways in a small boat 50 feet to 100 feet offshore, and watching for trails left by the crocodiles on the shore. We also search likely-looking thickets on high ground above beaches, or banks along the deeper narrow tidal creeks which empty into the bay. The nest mounds that we have examined were between seven feet and 35 feet from the nearest water, and at some sites were easily visible from our boat. It is not unusal to find two nests, both newly constructed, within 100 feet of each other. Invariable, however, only one of the two nests will contain eggs. In such cases, we believe both nests are built by the same female, but we cannot thus far explain the purpose of the empty nest.

A female crocodile lays her eggs clumped together in a pocket near the center of the nest mound. Apparently the eggs are laid in the mound before it is completed. After the female lays the eggs, she covers them with six inches to 10 inches of sand or marl. The 10 nests we opened briefly contained between 18 eggs and 53 eggs each, with an average clutch of 37 eggs a nest.

Adult crocodiles, presumably females, help newly-hatched young escape from the nest mounds. The adult digs out the side of the nest, or opens it at the top. Female assistance seems necessary for young to escape marl nests, which become brick-hard during the summer incubation period. In the more porous sand nests, some young crocodiles may dig their way out of the mound unassisted.

Our experience with newly-hatched crocodiles is

that they are almost entirely silent, in contrast to hatchling alligators, which frequently produce a whimpering call in the nest. Therefore, we are uncertain how adult crocodiles determine when hatching has occurred and when nests must be opened.

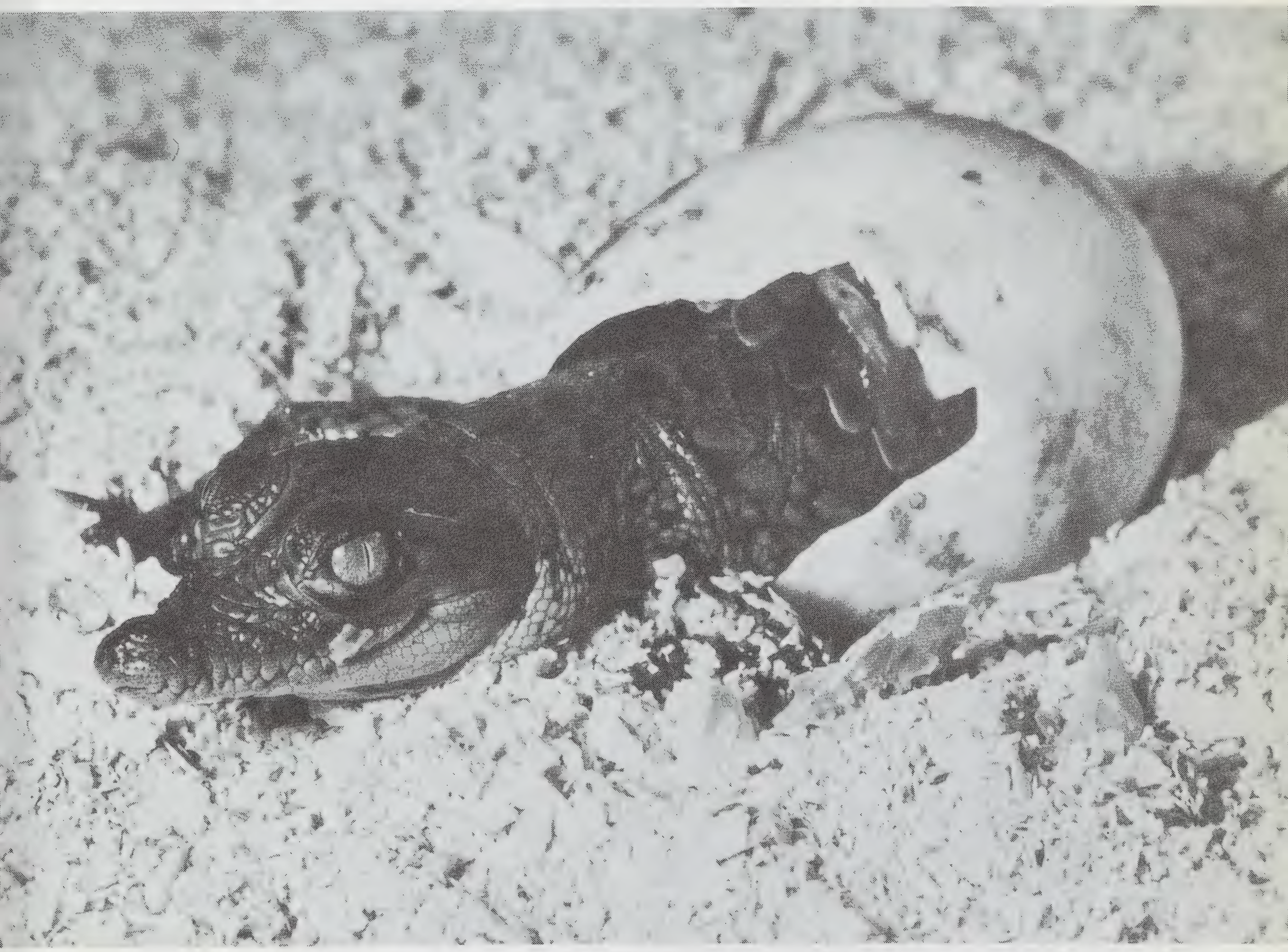
During the summer of 1970, we found that eggs laid in early April hatched during the beginning of August. It is possible that this prolonged incubation period, of more than 100 days, decreases the chances of hatching success, especially during summers of unusual extremes in weather. However, 157 crocodiles hatched from 244 eggs in seven nests we checked during 1970. We were pleasantly surprised at this high rate of hatching. However, we suspect that if such hatching success occurs in most years, there must be fairly high mortality among juveniles, otherwise the crocodile population would be larger than it apparently is.

Admittedly we have only guessed at the actual size of the Florida crocodile population, and because of the nocturnal habits of the crocodile, we may have underestimated the numbers that exist. Moreover, the crocodile is very secretive, and we rarely have seen them at nests. Whatever visits female crocodiles do make to their nests apparently are at night.

Our population estimate is based on the assumption that for each active nest we found, there should be at least one mature female, one mature male, and perhaps as many as 10 or 20 subadult crocodiles. However, there must be more nest sites than the 10 we have seen, so our estimate of from 200 to 500 crocodiles in south Florida may be subject to considerable revision.

If the crocodile population of Florida Bay has been reduced because of human activities, then suitable feeding and nesting habitats now must be unoccupied. If the detrimental human activities can be identified and corrected, then crocodiles might be restocked in vacated but suitable habitats.

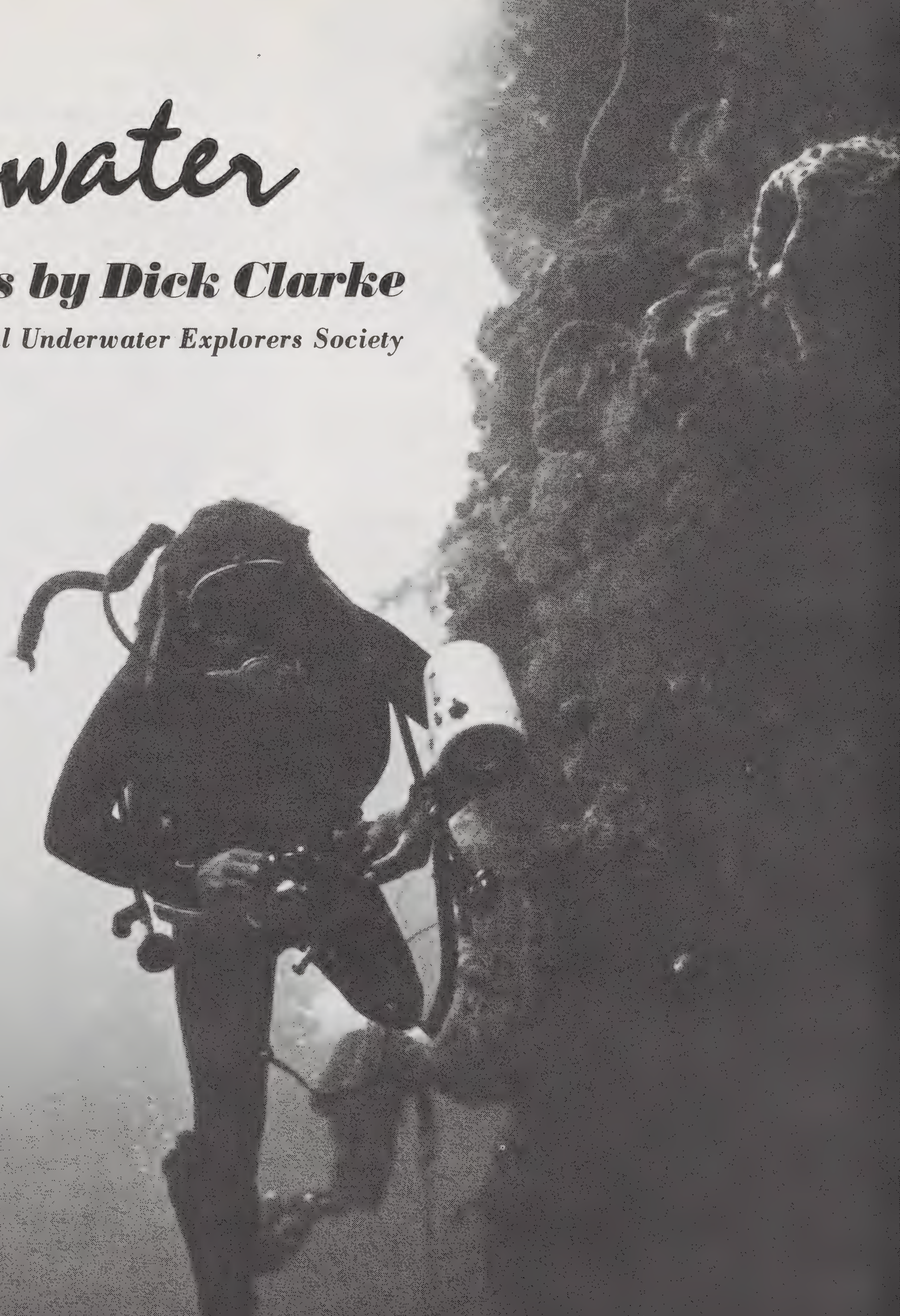
A hatchling emerges from the egg in an artificial nest box. Information gathered from crocodiles reared in captivity (such as the 11-month old youngster pictured on page 7) is compared with data obtained in the wild.



Underwater

Photographs by Dick Clarke

International Underwater Explorers Society



The photographer who goes underwater enters a world of drifting sunlight, of invertebrates that look more like flowers than the animals they are, and of fish — some colorful, some dangerous — all inhabitants of the vast water world where man is but a visitor.

The colonial tunicate (shown on page 13), sea whips (at right), and feather-duster worms (below, right) are all invertebrates, animals without backbones.

Although appearing to swim head downward, the trumpetfish (opposite) uses this posture for camouflage amidst such "stalky" invertebrates as (opposite, from left to right) sea whips, sea fans, and sea feathers.

A stingray (left, top and middle) glides through the water and settles in the sandy sea bottom; a sharp, venom-bearing spine on the upper surface of the tail is cause for this fish's dangerous reputation. The flounder (bottom) is a flatfish, which characteristically lies flat on the ocean floor.

The barracuda does not attack invariably and on sight; nevertheless its razor-sharp teeth in a large mouth are reason enough to make a diver wary in its presence.

The Red-Cockaded

The flutter of wings and a loud call broke the myriad of forest sounds as an adult red-cockaded woodpecker *(Dendrocopos borealis),* with an insect in its bill, approached a pine tree nest-cavity where its young waited. The expectation of food elicited an animated reaction from the young. The excitement of the nestlings was matched by the enthusiasm of the authors as we recorded this seldom-witnessed event. We were in the Francis Marion National Forest to study the red-cockaded woodpecker, which the United States Fish and Wildlife Service has added to the federal endangered species list. Our mission was to investigate the relationship of the bird to its habitat, as part of the effort to insure the survival of the species.

The red-cockaded woodpecker was once a common bird in the extensive pinelands of the Southeast. Here, it found an abundance of mature and aged trees, particularly those with red heart disease *(Fomes pini),* which are required for the bird's nest and den cavities. The woodpecker's habit of denning and nesting in live mature pines with red heart conflicts with modern forest management practices of eliminating diseased trees, which is the primary reason for the decline of the bird. While the woodpecker presently is quite scarce throughout its range, it is still common in a few isolated locations. South Carolina boasts the largest population, and the Francis Marion National Forest and the International Paper Company's Koppers-Hemingway Tract support the greatest known concentrations.

When the red-cockaded woodpecker was placed on the endangered species list, it was perhaps one of the least-known of the North American woodpeckers. Its endangered status gave impetus to research, which led to a symposium in May 1971 on the ecology and management of the species.

This woodpecker is a gregarious species that flies, feeds, and lives in colonial groups of from two to 10 individuals. The woodpeckers maintain a continual chatter, supposedly to keep the group together as the birds feed during the day. Roosting takes place

A red-cockaded woodpecker comes in for a three-point landing—using its feet and tail (opposite). The species nests and dens in mature trees, particularly those with red heart disease.

After the death of the tree, other wildlife species often utilize red-cockaded woodpecker's dens, such as the pileated woodpecker, shown at left with two chicks.

Woodpecker

An Endangered Species in Its Environment

by Ted E. Lynn and Melvin L. Hopkins

in small clumps of trees. Occasionally, when there is not a sufficient number of dens for all members of the group, a bird will have to roost outside a den cavity. Distance between den-cavity trees when there is not a colony ranges from a few feet up to about 700 feet, with an average of approximately 200 feet.

One cavity tree within each colony is used for nesting. For unknown reasons, not all colonies have an active nest each year. Normally two or three glossy white eggs are laid in a nest, but nests containing one egg to five eggs have been reported. Incubation, by both members of the monogamous pair, lasts from 10 days to 11 days. In most cases, other birds of the colony help the parents feed the young. The feeding period lasts about four weeks, until the young leave the nest. In nesting colonies, one brood per year is raised each nesting season, which lasts from mid-April to the first of June.

The typical den of the red-cockaded woodpecker has an area cleared of bark around the entrance hole. Small holes are drilled for a considerable distance above and below the entrance hole to serve as wells which drain pine pitch from the tree. The oozing pitch makes the den tree very conspicuous. The reason for the pitch drainage has been debated, but the most accepted theory is that it helps protect the den from predators. It could also identify den trees for the birds. The den trees are used for years, until they die, stop oozing pitch, or decay excessively.

The natural mortality rate of den trees ranges up to five percent per year, so the woodpeckers regularly must peck new dens in suitable trees. It takes one year or more to complete a den, but if a sufficient number of suitable trees exists, the birds can maintain a colony.

The entrance hole is approximately two-and-one-quarter inches in diameter and slopes slightly upward to the cavity, which with few exceptions is located in diseased heartwood. The cavity itself measures approximately three inches to three-and-one-half inches in diameter and from six inches to 12 inches deep.

A red-cockaded woodpecker arrives at the nest with an insect for the young waiting inside. The bird is distinguished by the large white cheek patch and "ladderback" pattern.

Den cavities are commonly made below decayed knots in the trees. The oozing pitch below the den probably helps to protect it from predators and could also identify den trees for the birds.

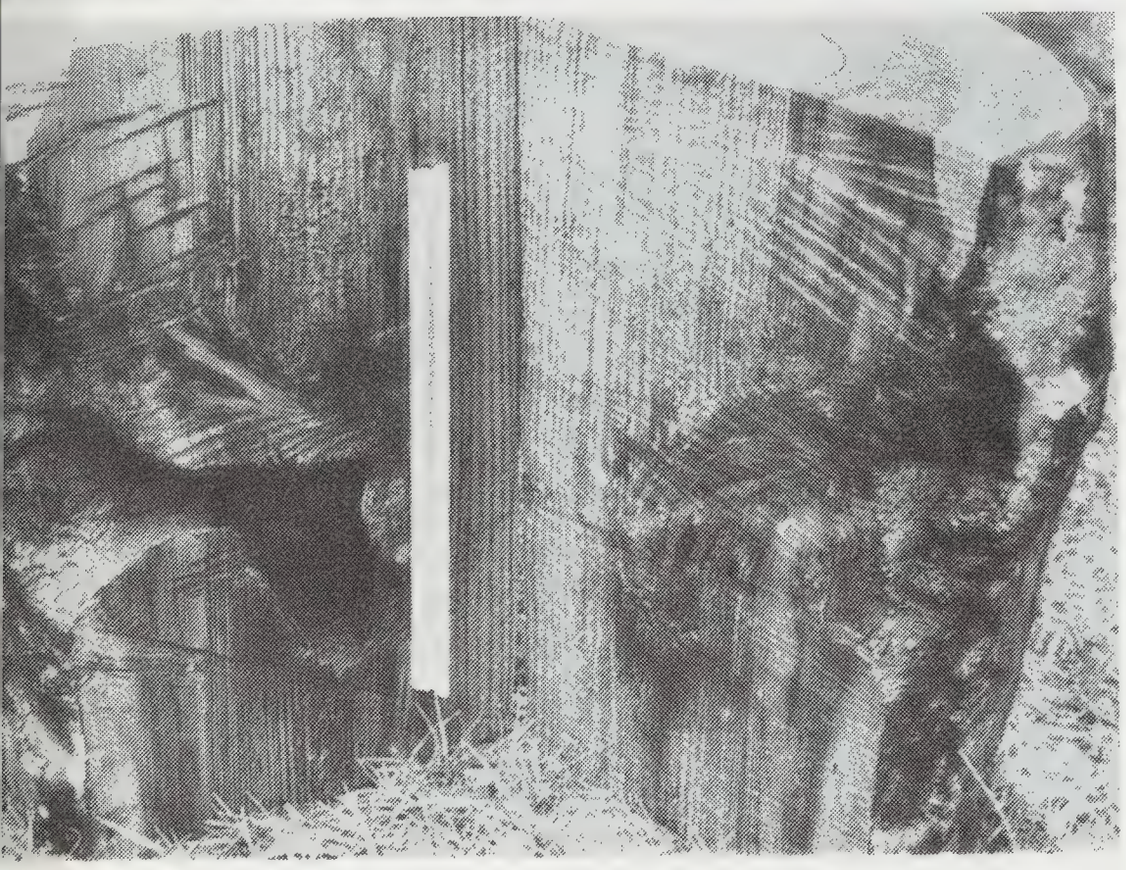
The dens, usually built in trees from 10 inches to 25 inches in diameter, are located from a few feet to 80 feet or more above the ground. The average height of dens is about 30 feet. Customarily, one den per tree is the rule, but older colonies or colonies located in limited habitat tend to average more dens per tree. Nearly three-fourths of the dens we found during our study faced in a westerly direction.

The food of the red-cockaded woodpecker is primarily forest insects, with a few small fruits and seeds in season. The birds feed heavily on corn-ear worms when these are available. Unlike the red-bellied woodpecker *(Melanerpes carolinus)* and the yellow-shafted flicker *(Colaptes auratus),* the red-cockaded woodpecker never feeds on the ground.

The four tree species in which the woodpecker builds its dens are longleaf pine *(Pinus palustris),* loblolly pine *(P. taeda),* shortleaf pine *(P. echinata),* and pond pine *(P. serotina),* all of which are southern yellow pines capable of a substantial pitch flow. The bird needs mature or aged trees generally 60 years old and more, because of the necessity of heartwood and red heart disease. A few dens have been reported in younger trees and trees not diseased with red heart, but these have been exceptions.

Regardless of tree species, the red-cockaded woodpecker apparently prefers open, park-like stands of trees. These are most often found in longleaf pine in the Coastal Plain and loblolly pine in the Piedmont, where longleaf is scarce. However, the bird readily utilizes denser stands for feeding.

The red-cockaded woodpecker provides niches for other wildlife species. Its dens are utilized by the red-headed woodpecker *(Melanerpes erythrocephalus),* yellow-shafted flicker, red-bellied woodpecker, eastern blue bird *(Sialia sialis),* brown-headed nuthatch *(Sitta pusilla),* great crested flycatcher *(Myiarchus crinetus),* flying squirrel *(Glaucomys volans),* and other creatures. Some intruders may



The photograph at the top shows a sectioned den with the entrance hole (top, left) and the den cavity beneath. The photograph below is of a sectioned den showing the enlarged entrance hole and a shallow cavity. The normal mortality rate of den trees ranges up to five percent per year, so the red-cockaded woodpeckers regularly must peck new dens in suitable trees.

drive out the red-cockaded woodpecker, take over the den, and enlarge the entrance to suit their needs. After the den tree dies and is abandoned by the red-cockaded, it still remains useful to other wildlife. Large birds, such as the pileated woodpecker *(Dryocopus pileatus),* enlarge and use the cavity. Wood ducks *(Aix sponsa)* and tree squirrels also set up housekeeping in the enlarged dens.

Based on our study, we have developed minimum guidelines for management to perpetuate the endangered red-cockaded woodpecker as a species. Den trees should be pinpointed on property maps as near to their exact location and relative position to other den trees as possible (this will assist in identifying colonies). In areas to be cut for timber products, a 2.8-acre (198 foot radius) minimum buffer zone should be left around individual den trees. Where colonies exist, the 198-foot buffer zone should be based on the peripheral den trees. This will usually result in less acreage per den tree. The buffer zone is necessary for the protection of the den trees from wind damage, logging, and other hazards. It also provides cover, feeding areas, and, hopefully, future den trees.

Den trees and the buffer zones should be conspicuously marked. When a buffer zone does not contain an adequate number of potential den trees, suitable trees outside the 198-foot buffer zone, if available, should be incorporated into a larger buffer zone.

The 198-foot buffer zone should be reduced to from 60 trees to 80 trees per acre, favoring the more mature trees. Logging should be excluded from the colonies and buffer zones during the nesting season. April 1 to July 1 is nesting season in South Carolina, although this may differ slightly in other states.

The den trees and colonies of the red-cockaded woodpecker should not be excluded from planned undergrowth burning programs. This practice helps produce open stands which are more attractive to the red-cockaded. However, the area around the base of each den tree should be inspected before any burning is done. If there is a large quantity of resin present, the flammable material should be raked away from the base of the tree.

The recommendations which we have made are general guidelines rather than definite rules. If followed, however, they would play a key role in insuring the survival of the red-cockaded woodpecker.

Rheas

PART II

In Argentina

by Donald F. Bruning

El Callejon, an estancia in Argentina, was the scene for a field study of the gray rhea by the author.

As I walked through the ornate metal gates and the large double doors of the old house, it seemed as if I had stepped back one hundred years in time. The walls of the hallway and living room were covered with mounted heads of wild boar and deer, racks of deer antlers, old paintings, and ancestral portraits. The furniture was of a time long past, with the solid feel that only good wood gives. The cool musty odor that hung in the air also bespoke age, although not decay. On the dining room walls were ornate and intricate works of silver from Bolivia and Peru, and other silver work filled the cabinets that lined the hallway.

Outside the old mansion, however, the formal gardens were overgrown, a sign of the beginning of deterioration. The loud calls of the white peafowl and guans that roamed freely around the grounds were enough to make the entire atmosphere unreal. This was "Callejon," a large estancia, or ranch, in the Buenos Aires province of Argentina.

I had come here not to study architecture or art, but to investigate the behavior and ecology of the rhea, scientifically known as *Rhea americana.*

For the past three years at the Bronx Zoo, we had raised nearly one hundred young rheas and had learned a great deal about their food requirements and behavior. Now we needed to observe rheas in the wild to determine if they behave and develop in the same way as our captive birds.

I left New York City on a cool November evening and a mere 10 hours later arrived at the Buenos Aires airport, where I was met by a very good friend of the

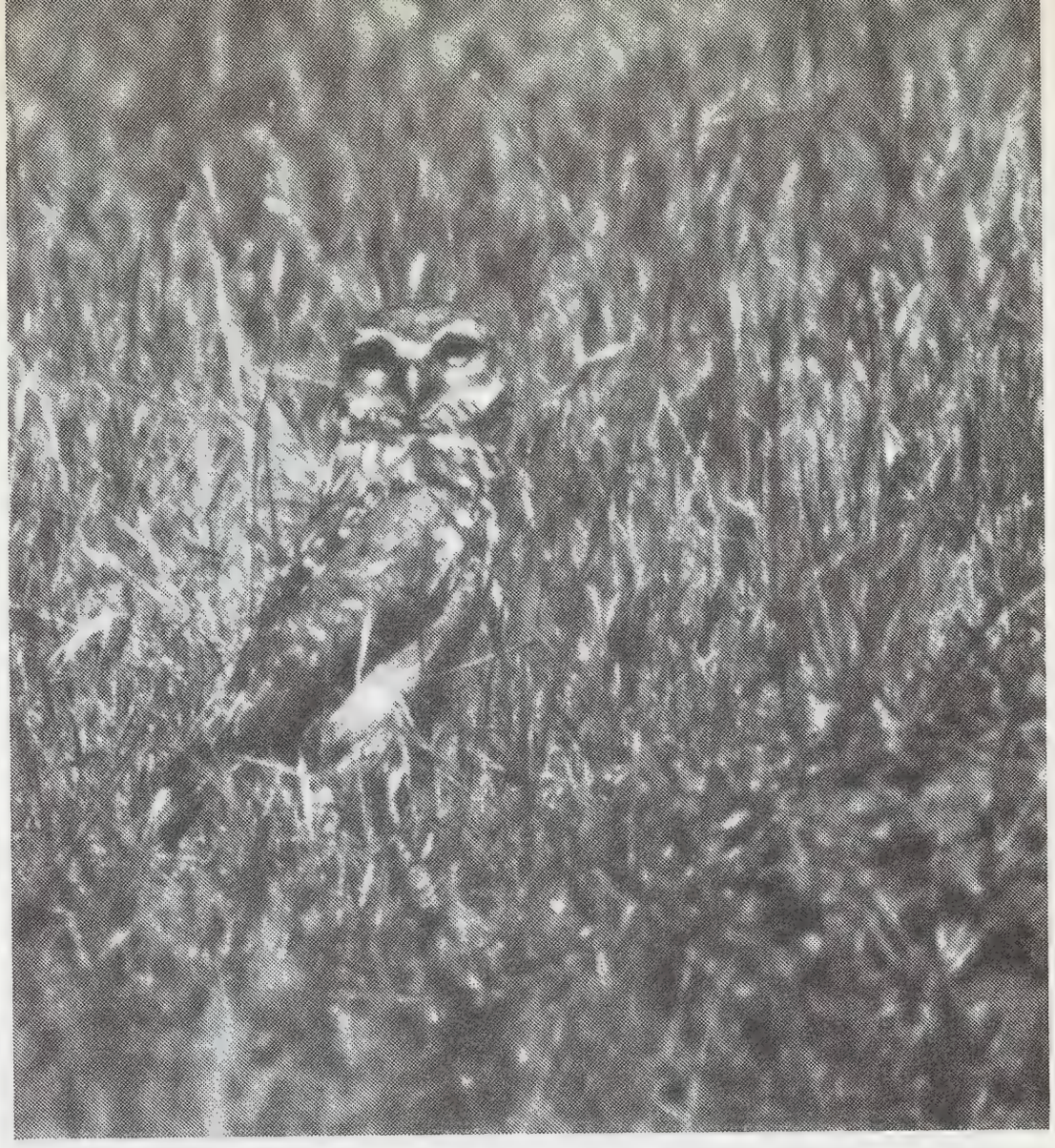
New York Zoological Society, Jaime Llavallol. Sr. Llavallol drove me down to his estancia, "El Arazi," 170 miles away. When we arrived, I was greeted by the strange call of the chimango *(Milvago chimango)*, a small bird of prey very common in the area that eats almost anything, including carrion and insects.

The following morning I was taken to Callejon, which would be my home for the next three weeks. We crossed a canal into the estancia and continued along a dusty dirt road. We passed through eight gates and each time we stopped to open one, we had to pause for a few seconds to allow the cloud of dust we had stirred to float past with the gentle breeze. Eventually we drove into a grove of trees and through the ancient gate at Callejon.

The estancia turned out to be an ideal place to study rheas. Its owners have not persecuted the birds, and Callejon is not along a major highway, so it is not possible for hunters to see the rheas without a long, dusty drive through several of the estancia's gates. Moreover, periodic winter flooding prevents agriculture in the region. All of these facts make Callejon a haven for the gray rhea.

After putting my things inside the main house, we drove to the home of Thomas, the old gaucho in charge at Callejon. Thomas took us out onto the vast pampas which stretched in all directions from the small grove of trees where he lived. He provided directions to where we could find rhea nests, and we were on our way again.

As we left the grove of trees, we drove right through a large group of 32 rheas, none of which paid any attention to our pickup truck, although we passed within 20 feet or 30 feet of some of them. Shortly, we noticed a male rhea sitting on his nest about 60 feet away. Holding my camera, I carefully



The burrowing owl, a species common to the area, usually builds its nest in an abandoned armadillo burrow but will on occasion dig one of its own.

got out of the truck and slowly approached the nesting bird, snapping pictures as I got nearer. When I was 40 feet or 50 feet from the bird, he jumped up and ran off. As he ran, he spread both wings and acted as though badly injured. This kind of distraction behavior, common in smaller birds that nest on the ground, is amazing to observe in a rhea. It seems strange that a flightless bird would still use a "broken-wing act" to draw a potential predator away from its nest.

That afternoon we examined five rhea nests in two large sections of pampas. Then Sr. Llavallol left, and I was alone at Callejon with the Spanish-speak-

A group of female rheas grazes on the estancia under the watchful eye of a male (far right), while a second male (second from left) waits patiently on the fringe.

ing gauchos and their families. Since I do not speak that language, I had to get along with the help of a small Spanish phrasebook.

The next morning, sunrise found me out on the pampas looking for rhea nests. I managed to find four of the five nests we had seen the day before and two additional nests as well, before the afternoon rains forced me to abandon my search. Once it starts raining, rheas lie down, and it becomes impossible to detect an incubating male without chasing at least a dozen other birds from their resting spots.

As soon as the sun rose the next day, I again headed out, only to find, as on the previous morning, that the rheas did not become active until about two hours after sunrise. I carefully checked the six nests that I knew of and found all had males sitting on them.

By ten in the morning, however, my truck had broken down. I gathered up my camera equipment and headed back toward a large grove of trees where I knew gauchos were shearing sheep. Luckily, it was only a few miles away, because a cold wind was blowing and rain was threatening. At the edge of the grove, an old automobile stood in front of a shed.

Hoping that someone would be there, I walked toward the shed and was greeted by a friendly "Buenos dias," as a man emerged from within it. After looking in my Spanish phrasebook for what to say and how to ask for repairs, I tried to communicate with him. To my surprise the man seemed to understand my poor Spanish, and he drove off in his ancient car to get the parts for repairing my truck. A few hours later, he returned and the truck was repaired.

During the period of my study, while driving about on the pampas, I found many single rhea eggs scattered about. Most of these lone eggs are laid by females accompanying a male that has not yet built his nest.

A male rhea spends about a week of courting before he builds a nest. During this courtship period, he gathers a harem of from one to 12 females. At first the male follows the females, but later after much displaying, he seems to lead them around. It is during the later stages of courtship that some females lay eggs before the male builds the nest.

The male constructs his nest by scraping out a shallow depression in the ground with his feet. He then lines the depression with a layer of grass, or any other material that he can reach from the nest site. Nest construction takes only a few hours. When the nest is finished, the male allows females to approach it and lay their eggs.

This male rhea was trying to incubate 62 eggs in one nest, more than he was able to cover at one time. Eventually the nest was abandoned.

Usually the male is sitting on the nest when the female approaches, so she simply lays the egg beside the nest and walks away. The male then rolls the egg into the nest with his bill. Such egg-rolling behavior explains why our rheas at the Bronx Zoo continually roll eggs around their enclosure.

When eggs are in the nest, the male leaves it only to feed, and then just for short periods The females return every day for about a week to lay eggs for the male. Each female usually lays eggs every second day. Once a male remains on his nest, the group of females is courted by another male. For several days the females continue to return to the first male's nest to lay their eggs; however, as the courtship ritual of the new male increases, they eventually follow him until he builds his nest. Meanwhile the first male is busy incubating the eggs, and he becomes more and more belligerent to the approach of any other rhea, male or female.

The males occasionally fight, but usually merely with threats and intimidation. When fighting over a group of females, the males use only their bills and necks. Usually threat is enough to frighten away an interloping male.

After my truck was repaired, I discovered that one male was not on his nest, which contained only three eggs and hundreds of pieces of egg shell. The other eggs had hatched. A dozen chimangos and caracaras *(Polyborus plancus)* were busy picking at the eggshells and membranes.

I had not gone far from the nest before a male jumped out of the grass, with 15 chicks tumbling after him. As the male tried to lure me away with the broken-wing act, he called to the chicks with a low grunting note and they scattered in all directions. One chick was so unafraid that it ran right up to my feet. When I picked it up for a brief inspection, it

started to struggle and to call until I put it down. The male then circled around, returned to the chicks, called to them, and headed off once more across the pampas. I followed him in the truck until late afternoon when it started to rain. As soon as the rain began, the male laid down and started brooding the chicks. At this age the chicks are very vulnerable to the elements, and rain is one of their worst enemies.

Unfortunately, it rained most of the night, but it was bright and sunny the next morning. I arose early and found the male just where he had been the evening before. He did not stir until nearly 9 A.M. and when he finally stood up, I could only count 14 chicks. Apparently one had either wandered off or died from exposure during the night.

A male with chicks is very alert and watchful. He spends most of his time leading the chicks away from potential danger, and during this period he attacks any creature that could threaten the chicks. Caracaras and rain seem to be the main threats to young healthy chicks. Caracaras continually attempt to sneak through the grass and catch chicks that wander too far from the male. A lone chick that

A male rhea performs the "broken-wing act" in an attempt to draw the author away from the nest hidden in the tall grass.

When a female wanders too close to a male rhea with chicks, he calls to the youngsters, which cluster behind him, and lunges at the interloper, driving her away.

is either wet or tired also is easy prey for the chimangos, which are everywhere. However, once the chicks are a few days old, they are relatively safe from predation on the ground, as long as they are healthy and strong.

Each day the chicks I was watching became physically stronger and capable of traveling farther and farther away from the male. By the time they were two weeks old, they would wander 50 yards to 75 yards away from the male, although they would follow him carefully. The male, meanwhile, slowly became less and less watchful as the chicks grew. He spent more time feeding and less time on the lookout. As the male slowly wandered about, the chicks followed a pattern of feeding, running after the male, feeding, and catching up with him once more. This continued all day.

The male does not rest at all during the day until the chicks are much older; he continually feeds and moves along. In this way the male probably stimulates the chicks' feeding behavior and exercises them, strengthening them and stimulating their appetites. The male also may be trying to regain the weight he lost when the task of incubation restricted time for feeding.

The adults feed mainly on plants but also eat insects or, for that matter, almost anything else they find. The young chicks follow the example of the male and begin eating greens during their first day of life. Clover and other small plants seem to be major food items for the young chicks until they become strong and quick enough to catch insects. By the time the chicks are a week old, they feed on many types of insects and broad-leafed flowering plants. The adult rheas did not eat as much grass as I had expected, but fed largely on broad-leafed plants. Rheas also eat their own eggshells, from which they may derive calcium.

We wanted to compare the weights and sizes of several wild chicks with similar data from the chicks that we had raised back at the Bronx Zoo. With this object in mind, I drove the truck to where the male was brooding his chicks. As I approached, the male moved away, performing a broken-wing act to draw my attention. By maneuvering the truck, I separated one chick from the male and the other chicks. Once this was accomplished, I stopped the truck and jumped out to catch the lone chick. Running as fast as I could, I overtook the chick, but when I tried to grab it, the chick made a quick about-face and headed in the opposite direction. I turned around and ran faster only to find that my juvenile quarry was adept at a dizzying series of evasive maneuvers, including abrupt reversals of direction. Again and again I tried, thinking that this tiny chick must be tiring. But its quick turns were too much, and I finally gave up and collapsed on the ground from exhaustion. While I lay there on the ground, it occurred to me that chasing young rheas might be great practice for defensive backs on football teams, but not necessarily for zoologists.

Nearly 15 minutes went by before my feet and legs could carry me back to the truck. I could hear the lonely cry of the chick trying to find the male and the other chicks, and I finally spotted it with binoculars. This time I vowed to use the truck to tire the chick.

After a 10-minute chase, the chick seemed extremely tired; I jumped out to get it, grabbing my old sweatshirt from the seat beside me. After a couple of tries, I was doing no better than before, so I rolled my sweatshirt into a ball and threw it at the chick in an attempt to trip it. I missed, but on the second throw I knocked the chick off its feet and grabbed it. After weighing and measuring the chick, I returned it to the male, which came when he heard the young bird's call. The chick ran quickly to the male and the other chicks; then the male quickly led them all away.

For 20 days I watched the rheas, observing parental care of eggs and young. During this period I found a total of 26 nests, in which six clutches hatched during my stay. The clutches incubated by the males numbered from seven eggs to 62 eggs. In actuality, the male trying to incubate the 62 eggs was unable to cover all of them, and at least six to 10 were exposed at all times. This male eventually abandoned his nest.

Many rhea nests are abandoned before the eggs hatch. Some males even construct two or three nests before they settle down to incubate. However, once a male starts incubating, he is unlikely to abandon the nest unless disturbed excessively.

I spent my last day in Argentina in Buenos Aires, a beautiful city with many attractive small shops in its downtown section. Unfortunately, these shops display for sale large quantities of vicuna and crocodilian products, a practice which is contributing to the rapid decline of these animals. To my horror, I even found rhea-skin wallets and rhea-toe charms for sale.

The rheas along with many other species have been designated as agricultural pests and so have been slaughtered in large numbers. It is due mainly to a few estancias like Callejon that the rheas are not in an even more distressing situation. Unless these large birds are protected in some way, they too will become endangered and eventually disappear as the human population of the region grows. If the rheas become extinct, it will be a grave loss, not only to Argentina and to South America, but also to the entire world, because these animals are unique to South America.

I returned to New York City with high hopes that with the new knowledge we are accumulating, we will be able to have greater success rearing rheas and strengthening the effort to preserve this species.

The male gray rhea (left) is distinguished from the female by the dark area on the neck. Behind the pair is a patch of thistles, a food source in the wild.

animal kingdom REPORTS

Bronx Borough President Robert Abrams (at left) and William G. Conway (at right), general director of the New York Zoological Society, joined with zoo and community volunteers and pitched in to pull debris, such as an old wooden chair, from the Bronx River on clean-up day, November 13, at the Bronx Zoo.

AWARDS TO ZOO AND AQUARIUM

Each year the Edward H. Bean Awards for noteworthy breeding in zoos and aquariums are presented at the annual convention of the American Association of Zoological Parks and Aquariums. In 1971, at the convention held in Salt Lake City, the award citations were given to the Bronx Zoo for the hatching of a tufted puffin, *Lunda cirrhata* (see "Animal Kingdom Reports," ANIMAL KINGDOM, October 1970, p. 30), and to the New York Aquarium for the breeding of the black piranha, *Serrasalmus rhombeus* (see "Piranha," ANIMAL KINGDOM, August 1971, pp. 18-19).

At the AAZPA convention, awards are also presented by the American Association of Zoo Keepers to the keepers of the Bean Award-winning animals. AAZK awards this year went to C. James Bardsley and Robert Edington of the Bronx Zoo for the tufted puffin, and to Werner Schreiner of the New York Aquarium for the black piranha.

BRONX ZOO HOSTS SEMINAR

A museum seminar on education and exhibition techniques, sponsored by the New York State Council on the Arts, was held at the Bronx Zoo on November 4 and 5. Organized by Mrs. Sally Duff of the Museum of the Hudson Highlands, Cornwall-on-Hudson, the two-day program of demonstrations and discussions was attended by staff members from natural history museums in New York State.

The participants were given a tour of zoo exhibits, including a preview tour of the World of Birds, which is scheduled to open in 1972. Also featured was a visit to the zoo's workshops for demonstrations of exhibition techniques, under the direction of department curator Jerry Johnson.

A discussion of animal health and maintenance was chaired by Bronx Zoo veterinarian, Dr. Emil P. Dolensek. Other discussions were led by Lewis Rems of the New York State Museum, Albany, and Gordon Reekie of the American Museum of Natural History, New York City.

This was the first in a series of seminars to be held at various museums throughout New York State.

On exhibit in the Monkey House at the Bronx Zoo is a proboscis monkey baby, shown above with its mother. Born on October 5, the youngster is the first of its species to be bred at the zoo.

A PRECIOUS HANDFUL

The proboscis monkey *(Nasalis lavatus)* is a rare sight, in captivity as well as in the wild, so it was a cause for rejoicing when a baby was born on October 5 to a pair of proboscis monkeys at the Bronx Zoo, a first breeding for this species at the zoo.

A delicate animal to maintain in captivity, the proboscis monkey is native to Borneo, where troops live along the river banks, feeding on leaves. The adult male has a long, pendulous nose -- from which the species gets its name -- that may overhang the mouth by three inches. The female has a shorter nose, and the baby's nose actually turns upward. The species has been bred in a few zoos, including San Diego and Frankfort, but a birth is still a rare occasion.

VOLUNTEER ZOO GUIDES NEEDED

The Volunteer Services of the New York Zoological Society, which has trained almost 100 people as guides for school classes and other groups at the Bronx Zoo and Central Park Zoo, has opened a drive to recruit additional volunteer guides.

Volunteers undergo a training course consisting of eight two-hour weekly sessions. Training lectures are given by members of the curatorial staff of the New York Zoological Society, which operates the Bronx Zoo.

Once the volunteers complete training, they are expected to serve as guides at either zoo for a two-hour period every other week. There are two guide programs, one for volunteers who wish to train and serve on weekends, the other for those who prefer weekdays.

The volunteer guide program, under the direction of Mrs. Samuel Symonds of Manhattan, has been in operation for almost a year. Prospective volunteers may obtain additional information by contacting Mrs. J.R. Perrette, 17 East 79 Street, New York, New York 10021 (212) 861-5852.

THE bookshelf

WILD ANIMALS AS PETS. *By Richard K. Matthews. 208 pages. Doubleday & Co., Inc., Garden City, New York, 1971. $6.95.*

A book about appropriate wild animal pets should only include animals that are safe to keep, that can be kept easily, and that are plentiful in the wild.

Unfortunately, this book is lacking in each instance. The care of potentially dangerous animals, such as chimpanzees, tigers, and wolves, should never have been discussed. Many of the baby wild animals in this book are harder to raise than the book implies. The numbers of South American monkeys and small cats caught and shipped to the United States for the pet trade are helping to eliminate them in many parts of their ranges.

Personal experiences with many mammals are included in this book. They tell of humorous and enjoyable experiences that lead the reader to believe that the animals and their owners lived happily ever after in every case. The Bronx Zoo and zoos throughout the United States get phone calls and letters every day from people who are trying to find a home for a "pet" ocelot, woolly monkey, kinkajou, squirrel monkey, wolf, or even a lion. Their reasons are all much the same: their pet has bitten or scratched someone, is destructive, or cannot be housebroken. Zoos are prepared to take very few of them. Many become dependent on a human relationship and are incompatible with members of their own species. Others, because of improper care, are sickly and a risk to a zoo collection.

Many of the diets suggested in this book are taken from *The Management of Wild Mammals in*

Captivity written by Lee S. Crandall, the late General Curator Emeritus of the Bronx Zoo. Though these diets may be adequate, few are now in use at the Bronx Zoo, although this impression is given. Animal nutrition is a continually changing field, and were Mr. Crandall alive today, he would have noted improvements in feeding.

It is distressing that a book such as this popularizes many wild animals that may eventually become endangered or extinct, in part due to the pet business, when the animals are not suitable pets anyway.

James G. Doherty

A PRIMER OF POPULATION BIOLOGY. *By Edward O. Wilson and William H. Bossert. 192 pages. Sinauer Associates, Inc., Stamford, Connecticut, 1971. $3.95.*

This book is precisely described by its title: it is a primer textbook on population biology written for college-level students. It contains three major sections—one each on population genetics, population ecology, and biogeography and species equilibrium.

The authors have set forth the subject in clear concise explanations and accompanied by mathematical proofs and models. An understanding of simple Mendelian genetics and some calculus, or at least statistics, is a requisite for using the text. Each section contains sample problems that can be used by the reader to test his or her understanding of the subject.

A few of the many topics covered are characteristics and magnitude of mutations, mutation pressure, gene flow, balanced polymorphism, genetic drift, population growth, predation, food webs and population stability, measurement of diversity, competition, and equilibrium. It is an excellent book for its designed purpose.

F. Wayne King

ALL UPON A STONE. *By Jean Craighead George. Illustrated by Don Bolognese. 42 pages. Thomas Y. Crowell Company, New York, 1971. $3.95.*

Many children's books provide delightful bedtime entertainment for their readers. I should imagine that *All Upon A Stone*—for those whose parents can afford the luxury of this hard-cover 42-page booklet—will qualify in this respect.

The story itself involves a mole cricket which sets about in search of another cricket like itself. In its journey to the top of a large weathered stone, the mole cricket encounters a variety of organisms—several, like the freshwater jellyfish, sponge, and fairy shrimp, in a most untenable situation. Early in its travels, the cricket unearths an incredibly sluggish spotted salamander, which has apparently dined heavily shortly before their meeting and chooses to let this delectable food item escape. At the story's close, the mole cricket has reached the top of the store and vocalizes its loneliness. Other crickets, like itself, soon gather together. After a brief but festive encounter, the mole crickets fly from their perch and retreat into the earth at the base of the stone.

Written with apparent sensitivity, both to subject and to young readers, it is indeed unfortunate that this book's merits are shadowed by its prohibitive cost and biological errors.

John L. Behler

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The Center for Field Biology and

In the Continuing Tradition of the New York Zoological Society

The society's new Center for Field Biology and Conservation will concentrate on research in the field. Many animals, such as the African cheetah are rapidly disappearing from the wild and must be studied while sufficient populations still exist.

The New York Zoological Society has established a Center for Field Biology and Conservation, which is devoted to the study of the natural world, a society tradition established by William Beebe at the turn of the century.

The center formally established January 1, 1972, actually had its origin in 1965 when the society and the Rockefeller University jointly created the Institute for Research in Animal Behavior, an act made possible with a grant from the Sarah Mellon Scaife Foundation, Inc. The institute was formed on the basic premise that animals can be understood only if they are studied as whole and complex beings, each intricately adapted to the environment. By combining the physical and scientific resources of the society and a university, it was hoped that the institute would conduct a series of investigations into animal biology with emphasis on how various behavior patterns function and what selective forces have shaped them.

Under the initial leadership of Dr. Donald Griffin and later of Dr. Peter Marler, the institute was a success from its inception. Not only can the impact of the institute be measured by the list of publications that have emanated from it, but also by the many students who have been stimulated to enter the field of behavior after having had contact with the research staff.

Research at the institute centered around two basic approaches, that of experimentally-oriented studies and expeditionary field studies. Dr. Griffin and his students have concentrated on the sensory systems of animals, particularly those of bats. Currently they are investigating the sonar capability which permits some bats to discriminate a flying insect from surrounding vegetation. A wind tunnel is used to measure directional patterns of sound emission in flying bats and other problems. In another line of research, migratory birds are being tracked by radar with the hope of finding out how birds are able to orient themselves inside the featureless environment of clouds.

Dr. Marler, Dr. Fernando Nottebohm, Dr. Paul Mundinger, Dr. Alan Lill, and their students have devoted their major research efforts to elucidating the communicatory systems of animals. Their findings on the language of emotions in Japanese macaques, chimpanzees, parrots, white-crowned

onservation

sparrows, gold finches, and other animals have, like much behavioral research, direct implications for understanding man. Certain species of birds, for instance, learn their songs from adults in a manner that is somewhat analagous to children learning to speak. Both have a critical period of learning, pass through a developmental phase of "babbling," depend on hearing their own voice for normal social development, and are predisposed to learn certain sounds more readily than others. Similarly, facial expressions and gestures of non-human primates may give important insights into human non-verbal communication.

Several studies were conducted at the William Beebe Tropical Research Station in Trinidad, which was closed by the society last year. Projects conducted there on the social behavior of parrots and manakins yielded insights into the evolution of polygamy and the relationship of social organization and ecological conditions.

Other investigations by the institute have focused on such varied topics as the recordings of vocalizations of humpback whales in Bermuda, the biology of drills and *Cercopithecus* monkeys in the rain forests of West Africa and Central Africa, and predator-prey relations of large mammals in the Serengeti National Park of Tanzania.

Any institution which has proven its worth ultimately strives to widen its scope and impact. Last year the Rockefeller University acquired the Innisfree Estate, with buildings, forests, and meadows, near Millbrook, New York. The acquisition provided the institute with an opportunity to expand. To fully exploit the potentials of such a field station, the research staff is moving its base of operations from the Bronx Zoo to the new site, a move which will reduce contact with the society. The institute will expand by dividing along natural lines of interest: the experimentally-oriented staff will base itself at the new field station, to be administered primarily by the Rockefeller University; and the field-oriented staff will retain its close ties with the society as part of the new Center for Field Biology and Conservation.

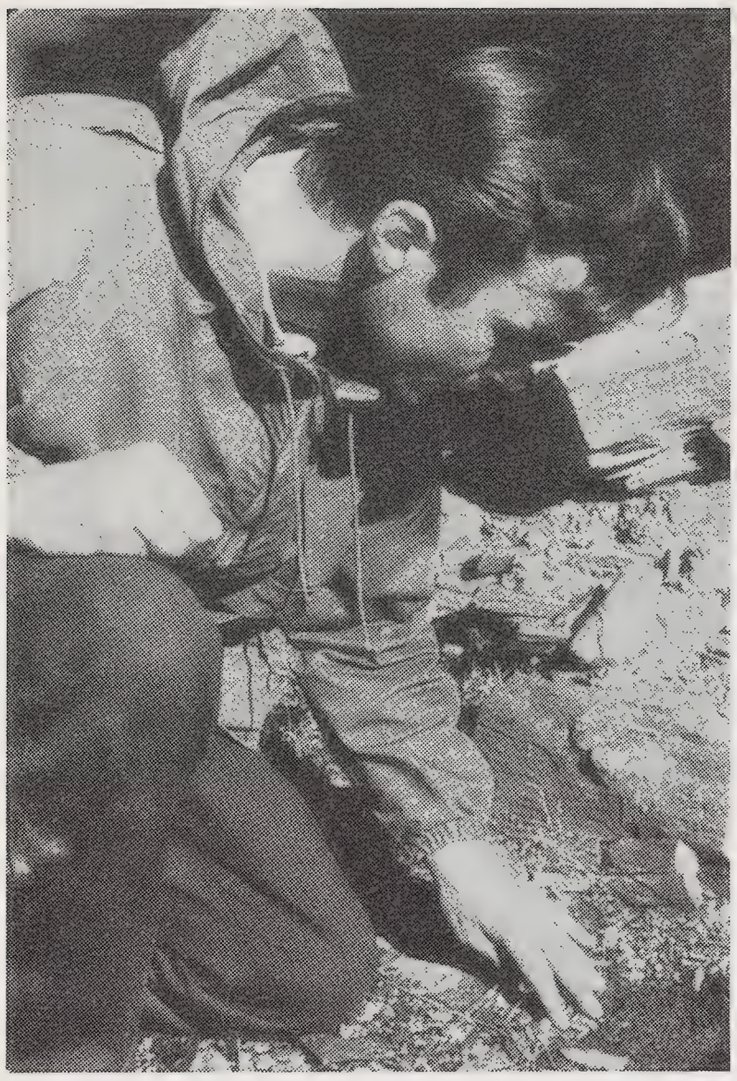
The society traditionally has been interested in field research. Not only has it had such eminent naturalists as William Beebe on its staff, but it has also over the years supported many projects

Deep in the Kibale Forest Reserve of Uganda, Dr. Thomas Struhsaker (above, left) will study the eight species of monkeys inhabiting the area, a project that may require more than five years of field research.

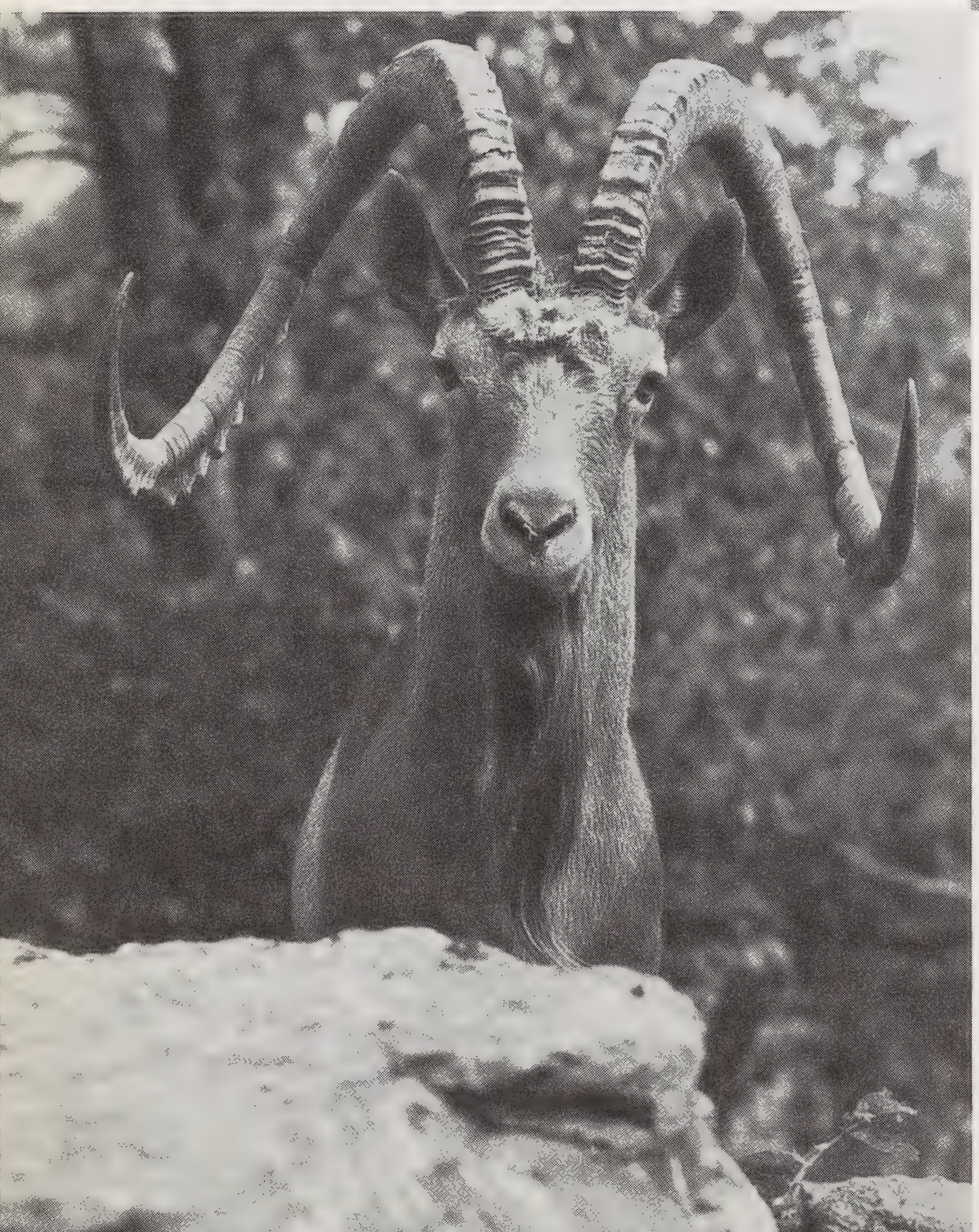
throughout the world. The new center is in part an outgrowth of this interest. With a grant from the Scaife Family Charitable Trusts, the center will provide several scientists with the opportunity to carry on field research unhampered by teaching, administration, and other duties. At present the research staff consists of three biologists, each with his own sphere of interest and each devoted to a long-term study of a group of animals, which, together with its habitat, is endangered.

Dr. Thomas Struhsaker, whose lengthy studies of various African forest monkeys are unequalled in depth and duration, established in 1970 a research station in the Kibale Forest Reserve of Uganda. He hopes to spend at least another five years in a study of the eight species of nonhuman primates that occur in the area, concentrating his research particularly on the sooty mangabey, red colobus, and red-tail monkey in different habitats.

By observing certain species intensively on a long-term basis, Dr. Struhsaker will be able to discern trends in social gropings, populations, and the ecosystem as a whole, and he will be able to relate particular aspects of behavior to certain habitat conditions. This, he hopes, will enhance knowledge of the relationship between ecology, phylogeny, and social organization among primates, a biological problem of great importance, for it may help to broaden our understanding of the genesis of human society.



Dr. George B. Schaller (above) examines a scrape made by a snow leopard high in the Himalayas (see also pages 7 to 13).

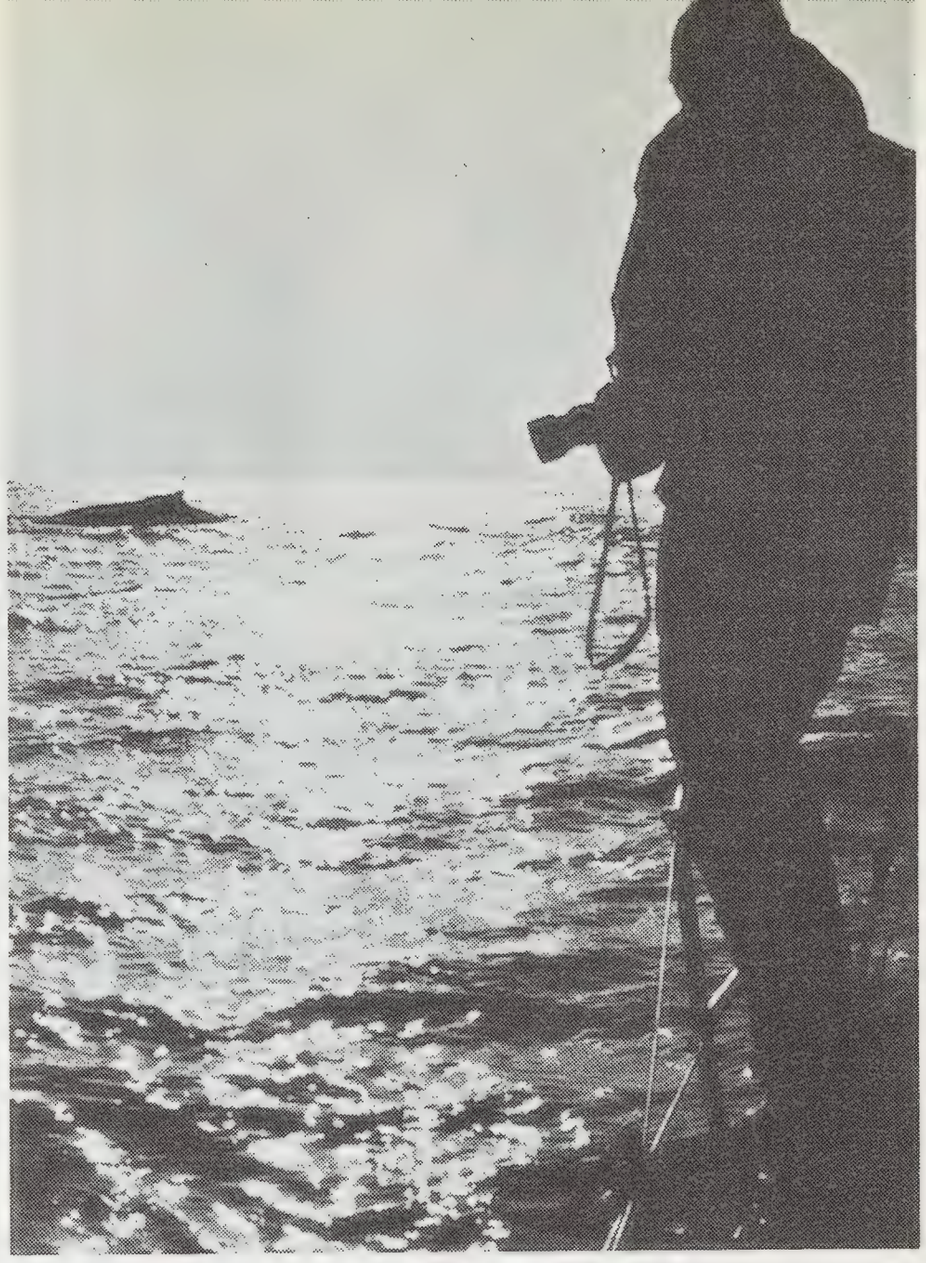


Himalayan tahr (above) and Siberian ibex (below, left) are representatives of the wild goats and sheep Dr. Schaller will be studying in the wild.

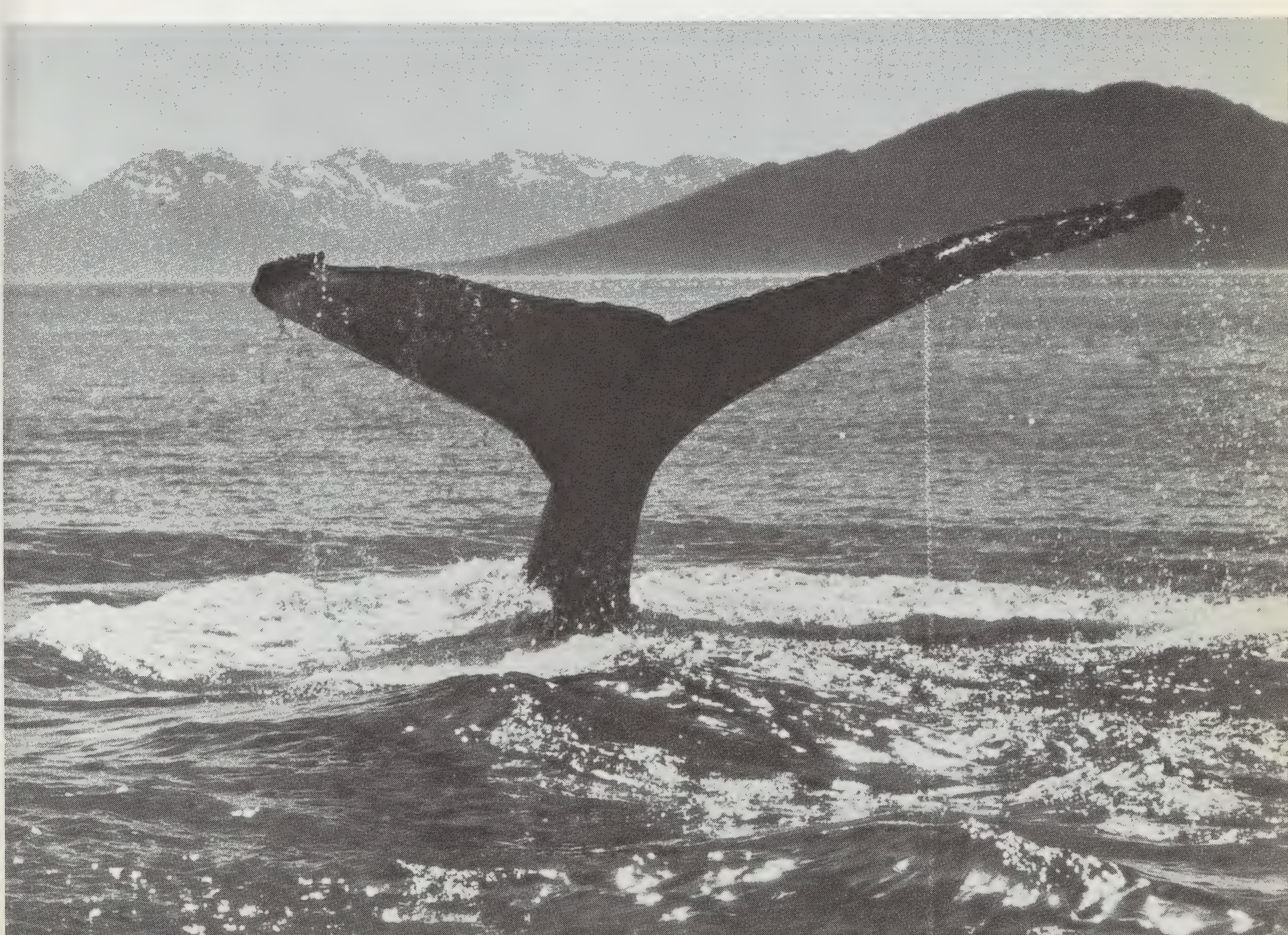
The high rampart of the Hindu Kush and Himalayan mountains from West Pakistan to the People's Republic of China harbors a distinctive fauna of large mammals about which little is known beyond some hunting accounts that were published more than 30 years ago. These animals present many tempting research problems. It would be interesting to determine their ecological and behavioral adaptations to the high and harsh environment in which they live. The area contains the greatest variety of wild sheep and goats in the world, including not only the Himalayan tahr, the markhor, the ibex, and the Marco Polo sheep, but also the bharal which is in many respects intermediate between the sheep and the goat. By studying the displays of these related species, a greater understanding of the evolution of behavior patterns may be gained. Since 1968, Dr. George Schaller has made several trips to study this fauna and he now plans to concentrate his research efforts in that part of the world.

The study of whales, particularly of the small porpoises, has increased but many basic facts about the biology and behavior of the larger species remain unknown. A site at which the large baleen whales could be kept under prolonged observation long has been needed. Dr. Roger Payne has found a herd of right whales in Patagonia where study conditions are ideal. He plans a five-year study in the region combining basic biology and behavior with particular emphasis on the role of sounds in the organization of this highly social species. Once abundant off the shores of all continents, but now among the rarest mammals on earth, this species lends itself to research for several reasons: each whale is recognizable as an individual by a set of distinctive knobs on the head which become visible every time the animal surfaces for air. This, combined with the right whales' tendency to stay close to shore and in very confined areas, makes it possible to learn about social behavior of groups in which known individuals of known sex and past history are living.

Although the Center for Field Biology and Conservation has an identity distinct from the institute and the field staff will be scattered over



Dr. Roger Payne (above) plans a five-year study of the right whale —— so called because it was once considered the "right" whale to hunt —— at a site off Patagonia in South America (below).



several continents, close contact with the Rockefeller University is being maintained. The present field staff holds appointments at the university, and students hopefully will participate in some of the field work, using the results for their graduate degrees. Scientists with suitable projects also might become affiliated with the center. In these and other ways, the center hopes to maintain contact with and contribute to the scientific community.

In addition to collecting scientific information, the projects of the center are also oriented toward finding ways in which various species and their habitats can be preserved. This approach is a continuation of the society's traditional role in conservation. The last chance to study populations of many vanishing animals in their natural habitat may be approaching. Each member of the center is dedicated to the task of somehow preserving samples of the wilderness.

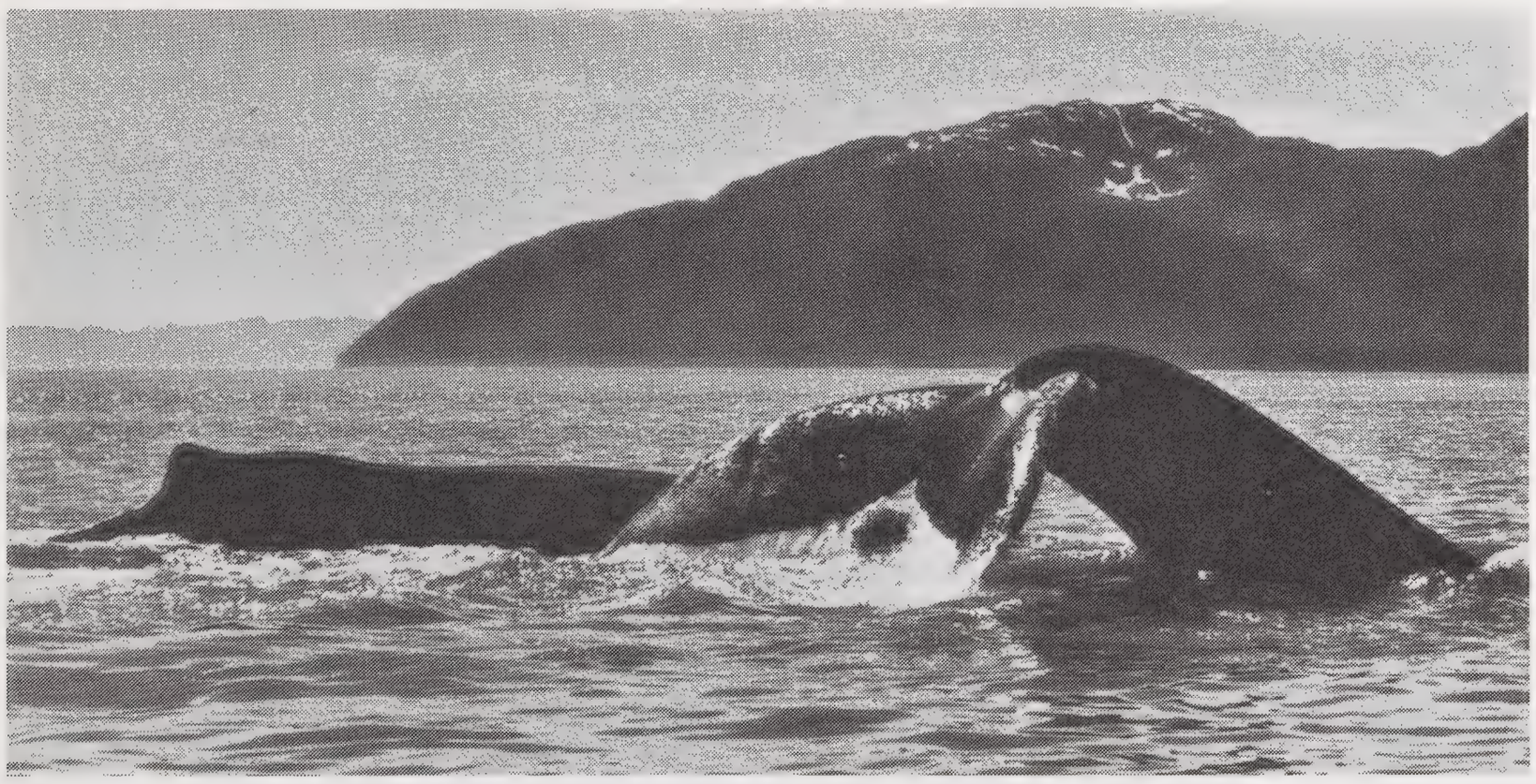
Dr. Struhsaker, for instance, is concerned about the exploitation of rain forests in Africa. He feels that this fragile and poorly known habitat must now be included in several inviolable reserves to prevent timber companies and agricultural activities from destroying the last primal stands.

The high mountains of Asia include such rare animals as the snow leopard and Kashmir stag. Knowing that the future of most of these animals is tenuous, Dr. Schaller is trying to find out their distribution and status with the hope that he can interest local governments in setting aside and maintaining a few remnants in sanctuaries.

Several species of whales have been brought to the verge of extinction through the greed and indifference of a few countries. Dr. Payne has become a spokesman on the whales' behalf. His recordings of the eerily beautiful songs of the humpback whale not only have entranced the public but also have drawn attention to the plight of these animals.

One of the functions of the center will be to further conservation by disseminating information through articles, recordings, and other ways, and by contributing facts and advice whenever these are needed.

If through its research the center can contribute to an understanding of the world's wildlife and if through its efforts even a small portion of the remaining wilderness is preserved, it will have fulfilled its purpose.



Once abundant, the right whale is now rare, a fate it shares with too many of the world's creatures.

George B. Schaller

On Meeting a Snow Leopard

A Top Biologist Comes Face to Face with a Rare and Beautiful Cat

Whenever I walk through the Bronx Zoo, I like to halt in front of the snow leopards. Their luxuriant smoke-gray coats sprinkled with black rosettes convey an image of snowy wastes, and their pale, frosty eyes remind me of immense solitudes. For a moment the city vanishes and I am back in the Hindu Kush, the home of these magnificent cats.

The December cold gripped the valley as soon as the feeble sun disappeared behind the ridge. The slopes and peaks above an altitude of 11,000 feet were snow-covered, and a bank of clouds along the distant summits suggested that soon so would be the valleys. I hurried down the trail along the edge of a boulder-strewn stream until the valley widened. There I stopped and with my binoculars scanned the steep slope ahead, moving upward past the scree and outcrops, past scattered oak trees and stands of pine, to a cliff over a thousand feet above me. A female snow leopard lay on the crest of a spur, her chin resting on a forepaw, her pelage blending into the rocks so well that she seemed almost a part of them. Several jungle crows sat in a nearby tree, and a Himalayan griffon vulture wheeled overhead, intent, I knew, on the carcass of a domestic goat that the leopard was guarding.

I angled up the slope toward her, moving slowly and halting at intervals, seemingly oblivious to her presence. She flattened into the rocks and watched my approach. Once she sat up, her creamy white chest a bright spot among the somber cliffs, then snaked backwards off her vantage point to become a fleeting shadow that molded itself to the contours of the boulders. She retreated uphill, crossing open terrain only when a tree or outcrop shielded her from my view. From another rock she peered at me, only the top of her head visible, but a few minutes later she stalked back to her original perch and casually reclined there. I was grateful for her curiosity and boldness, for she was so adept at hiding that I would not have seen much of her without her consent. I halted 150 feet away, and in the fading light unrolled my sleeping bag along a ledge in full view of her. Lying in the warmth of my bag, I could observe her feeding at the kill until darkness engulfed us. And then there was only the wind moaning among the boulders, and the occasional grating of tooth on bone as the leopard continued her meal.

That night it snowed, heavy moist flakes that soaked through my bedding. I huddled on the

A rare sight to see is the Asiatic race of the bearded vulture, or lammergeier, shown here soaring above the rocky crags.

ledge, sleeping intermittently, until the rocks once again emerged from the darkness. Over four inches of snow had fallen. As I rolled up my sodden belongings, I envied the snow leopard which sat protected and dry in the shelter of an overhang. I descended the slope through clouds and falling snow, heading toward the mud-walled hut that was my base camp in the valley. Though I was tired and chilled, the mere thought of having spent the night near a snow leopard filled me with elation.

With the support of the New York Zoological Society and the National Geographic Society, Zahid Beg Mirza of the Punjab University and I had come to Chitral in West Pakistan to make a month-long wildlife survey in the Chitral Gol reserve. This reserve, comprising about 30 square miles of rugged mountains with peaks rising to an altitude of 17,500 feet, has for many years belonged to the royal family of Chitral. Now His Highness Saif-ul-Maluke hopes to convert the area from a hunting reserve into a private sanctuary where visitors might observe the wildlife. Of particular interest to us were the Kashmir markhor goats, one of seven subspecies of *Capra falconeri.*

The markhor spend May to October at timberline and above, but they winter in the valleys where there is less snow and more food. In the Chitral Gol, evergreen oak trees provide the markhor with their main winter forage. It was startling to see these goats clamber with amazing agility among the branches of an oak tree, as high as 20 feet above ground, as they searched for tender twigs and leaves. Most of the herds we saw were small, ranging from two to 18 individuals, and usually consisted of several females, many of them accompanied by one or two kids, a yearling or two, and often some young males. Each herd tended to confine its movements to a particular locality.

On the other hand, the adult males, easily recognizable by their long, spiraling horns and flowing white neck ruff, roamed widely, either alone or in small groups. In late November and early December, some adult males joined the females in the herds, the first sign of the rut which was to reach its peak in late December. Only one large adult male accompanied a herd during the rut, a good indication that at that time relations between rivals were strained. Our census showed that about 100 to 125 markhor wintered in the reserve. The population was healthy and breeding was good. An average of 1.3 kids accompanied each adult female and 16-and-one-half percent of the population consisted of yearlings. If poaching could be fully controlled and the range less heavily used by domestic stock, the Chitral Gol might some day become the most important refuge for this increasingly rare goat.

One day, shortly after our arrival, we found old snow leopard tracks crossing a snow drift at 11,000 feet, and I became determined to meet one of these cats. Snow leopards live in the mountains of central Asia, usually occurring above an altitude of 5,000 feet, although in some areas, such as the Dzhungarian Ala-Tau of the USSR, they are found as low as 3,000 feet. Their range extends from the Hindu Kush in Afghanistan eastward along the Himalayas and across Tibet to the Szechwan province of China, and north-eastward along the Pamir, Tien Shan, and Altai ranges to the Sayan mountains that straddle the border between Mongolia and Russia near Lake Baykal.

Because of its remote habitat, coupled with its shy nature and rarity, the snow leopard remains the least known of the great cats. Most published accounts say little more than that they migrate seasonally up and down the mountains with the herds of wild sheep and goats that constitute their principal prey. Only occasionally do such accounts contain an interesting bit of information. In the Khirgiz Ala-Tau, for instance, snow leopards are said to rest in nests built by black vultures in low juniper trees, and a Russian biologist watched two snow leopards play, rearing up on their hindlegs

Dr. Schaller conducted a wildlife survey in West Pakistan's Chitral Gol reserve, 30-square miles of rugged mountains rising to an altitude of 17,500 feet.

and exchanging blows before "arching their backs at one another" and parting. Hari Dang, an Indian mountaineer, has seen snow leopards repeatedly and his article "The Snow Leopard and its Prey," published in the October 1967 issue of the journal *Cheetal,* represents the best attempt so far to gather information about this elusive cat.

For a week I searched for snow leopards, following tracks until they disappeared among the crags. A snow leopard in a zoo may mark its cage by rubbing its face sinuously against a log, scraping the floor alternately with its hindpaws, and then

With its long, soft fur, the snow leopard often is considered the most beautiful of the big cats. It may weigh as much as 100 pounds and reach a length of six-and-one-half feet.

turning, its tail raised and quivering, and squirting a mixture of scent and urine. At other times, it may scrape and then defecate at the site. Now, in the wild, I found similar signs. Occasionally a pungent odor on a tree trunk or rock told me where a snow leopard had left its "calling card," and scrapes, with or without feces, also advertised its presence. The feces revealed what the animals had eaten. I examined 16 droppings, and of these, five contained markhor hair, eight the remains of domestic sheep and goats, two solely a large-leafed herb, and one just earth.

Judging by tracks, a female with a cub and a small lone animal, probably a subadult, frequented the Chitral Gol during our visit, but other snow leopards no doubt also roamed through the area at times. The tracks showed that snow leopards, like most cats, were essentially solitary except, of course, when a female had cubs. Hari Dang saw snow leopards 16 times, of which 12 sightings were of animals alone and the rest of pairs. But whether the pairs consisted of a male and a female, a large cub with its mother, or members of the same sex was not specified. Nothing is known about the social system of snow leopards, and I wonder if adults are truly unsociable, like the African leopard, or if they may meet, tarry awhile together, and perhaps share a kill before parting again, as is the case among tigers.

I soon realized that my chances of meeting a snow leopard were slim. The cats were rare and they traveled far each day in search of food. The large herds of domestic sheep and goats which forage on the alpine meadows in summer had been taken to the villages. Marmots were hibernating. All that remained were scattered herds of markhor and various small animals, such as black-naped hare and chukar partridge, which could provide a snack at most for a predator that may weigh as much as 100 pounds and reach a length of six-and-one-half feet.

The lack of food in winter may force snow leopards into the cultivated valleys where they lurk around villages with the hope of capturing an unwary dog or other domestic animal. Often they are rewarded with a bullet instead. The demand for spotted furs by the fashion industry has also provided an incentive for killing the cats. Although both India and Pakistan prohibit the commerical export of snow leopard, any number of skins can be bought in local markets for about $150 apiece and smuggled without trouble out of these countries in personal luggage. The International Fur Trade Federation has agreed to impose a total ban on trade in snow leopard skins among its members, a step which will hopefully reduce the demand for this fur.

Having obtained some idea of the favored routes of the snow leopards in the Chitral Gol, I staked out a domestic goat as bait at five different locations. Daily for two weeks I checked each goat, feeding and watering it when necessary, yet the cats eluded me. One night a snow leopard passed within 150 feet of a goat, apparently without seeing it, for the tracks continued without deviation or break in stride.

I had almost given up hope of a meeting when

early one morning a sanctuary guard hurried toward me, pointing with his stick at the sky and grinning broadly. Circling high over a ridge near one of the goats were several vultures. A kill had been made. And then through my scope I saw the snow leopard at rest on a promontory. Beside her was a tiny cub, a black and white puff of fur about four-months-old. In captivity the usual litter consists of two cubs, but litters vary from one to four young. Later I was told by the sanctuary staff that this female had been seen with two cubs the previous month.

Daily for a week I watched the snow leopards, sometimes concealed on the opposite side of the valley, at other times near them. I moved a little closer each day until the female permitted me to approach to within 120 feet. Since she spent hour after hour at rest and the cub remained hidden, my behavioral observations were rather limited in scope.

At times I was able to watch a herd of markhor on a distant slope. The rut was now reaching its peak. If there was a female in heat, a large male might follow her closely, holding himself very

Of particular interest to Dr. Schaller and his associates was the Kashmir markhor goat, one of the seven subspecies of *Capra falconeri.* It is among the largest of the goats and is becoming increasingly rare.

According to the literature, cubs are usually born in April and May. Assuming a gestation period of 98 to 103 days, as determined in zoos, this cub had been conceived at that time and been born in August. Soon afterwards the cub retreated into a cleft among the rocks and remaind out of sight all day while its mother continued to guard the kill. Once a bold crow landed near the carcass and the female rushed at the bird, her movements remarkably smooth in spite of her stocky, powerful build. Afterwards she reclined again, dozing or gazing over her domain. At dusk the cub rejoined its mother, greeting her in typical cat fashion by rubbing its cheek against hers. They then fed. On subsequent days they followed the same routine with the result that I seldom was able to observe the cub.

erect until suddenly he lowered his neck and stretched his muzzle forward while his tongue flicked in and out of his mouth. With a jerk he twisted his head sideways, at the same time kicking a foreleg into the air. To this display the female markhor would often respond by walking hurriedly away. The male followed, which in turn caused her to move faster, until both rushed along the slope and through the trees.

At other times there were birds to observe. Two bearded vultures might be tumbling over and over in a display of aerial exuberance, their hawk-like

Two young bearded vultures rest on a rocky crag between aerial displays. This bird is also known as the bone-crusher because it extracts marrow from bones after dropping them from the air to smash on the rocks below.

screams the only sounds among these snow-flecked crags, or I might tally the bird species that passed by me – alpine chough, nutcracker, black-throated jay, pied woodpecker, and others.

After the snow leopards had eaten one goat, I gave them another and then a third. The female killed the last one late in the afternoon, as I watched. She advanced slowly down the slope, body pressed to the ground, carefully placing each paw until she reached a boulder above the goat. There she hesitated briefly, then leaped to the ground. Whirling around, the startled goat faced her with lowered horns. Surprised, she reared back and swiped once ineffectually with a paw. When the goat turned to flee, she lunged in and with a snap clamped her teeth on its throat. At the same time she grabbed the goat's shoulders with her massive paws. Slowly it sank to its knees, and, when she tapped it lightly with a paw, it toppled on its side. Crouching or sitting, she held its throat until, after eight minutes, all movement ceased. Judging by tooth marks on the throat, she had also killed the two previous goats by strangulation.

Hari Dang once watched a snow leopard attack a Himalayan tahr, a type of wild goat: "We were lying behind a boulder watching the thar (sic) climbing leisurely up the scree and the rock overhangs towards the north ridge of Raj Ramba peak, when a flash of white and grey fur dived into the spread out herd, and rolled down some hundred feet, all the time hanging on to a young thar ewe." At that point the snow leopard was disturbed by the observer and fled. Dang noted further that "of 17 natural kills seen, 11 were deduced on the basis of the evidence of the tracks to have been made in daytime, generally the early morning and late afternoon." In contrast to my observations, he found that of "34 natural and domestic kills. . . most were neatly killed, either with the neck or the spine broken."

One night the snow leopards departed. I traced their tracks past some outcrops and through a stand of pine, before deciding to leave the animals in peace. My meeting with them had been brief, too brief to teach me much of consequence, but on seeing the line of tracks continue upward, I hoped that some day I would return and learn more about the life of these phantoms of the snow.

No one knows how many snow leopards inhabit the mountains of Central Asia, but the animal is thought to be rare enough to warrant inclusion in the Red Data Book of the world's threatened species. Though the habitat of the snow leopard

seems inaccessible, pastoralists and hunters penetrate the remotest valleys and plateaus, shooting the cats and depriving them of their natural prey. Only large and strictly protected reserves may ultimately help the snow leopard to survive in the wild. Several reserves beside the Chitral Gol contain a few of the cats, among them, for example, the Nanda Devi and Dachigam sanctuaries in India and the Aksu-Dzhabagly Sanctuary in the USSR, but those in South Asia receive at best only the most cursory protection. Zoos are assuming increasing importance as repositories of breeding stock of threatened species. When in 1903 the Bronx Zoo received its first snow leopards, only two others were on exhibition elsewhere, in London and Berlin. By 1970, a total of 96 snow leopards resided in 42 zoos according to the International Zoo Yearbook. But of these only 20 were bred in captivity, a dismal record. Zoos still draw most of their animals from the wild, principally from the Tien Shan Mountains of Russia, because animals born in captivity seldom live to reproduce.

On seeing a snow leopard in a cage, I can forget the bars and remember when we met on a desolate slope in a world of swirling snow. May others, too, find such private visions until the end of time.

The snow leopard's pelage, pale gray or yellowish in color, with black spots arranged in open rings or rosettes, enables it to blend with the rocks of its mountainous habitat.

Anthony D. Marshall

A Walk with Nature in Madagascar

"God emptied his bag of Nature on Madagascar," a South African newspaper headline once read. It's true. Geographically separated from Africa at least 50 million and perhaps 200 million years ago, the island of Madagascar, known officially as the Malagasy Republic, has served as a refuge for wildlife and plant life found nowhere else. A tour through O.R.S.T.O.M.'s (L'Organisation pour la Recherche Scientifique et Technique d'Outre-Mer) Tsimbazaza park in Tananarive, the country's capital, is an eye-opener to the wildlife and plant life of the island.

Tsimbazaza first became a botanical garden in 1925. O.R.S.R.O.M. is a French public institution founded in 1943, operating in 25 countries in Africa, South America, the Far East, Lebanon, and Canada. In Madagascar, it has had since 1947 a research laboratory and ship, the *Vauban,* for oceanographic biology on the island of Nossi Be (off the northwestern tip of the Big Red Island), principally for research in the sciences of the earth, biology, and human science. The park provides a facility for first-hand study in a natural environment of mammals, birds, reptiles, and plant life indigenous to Madagascar.

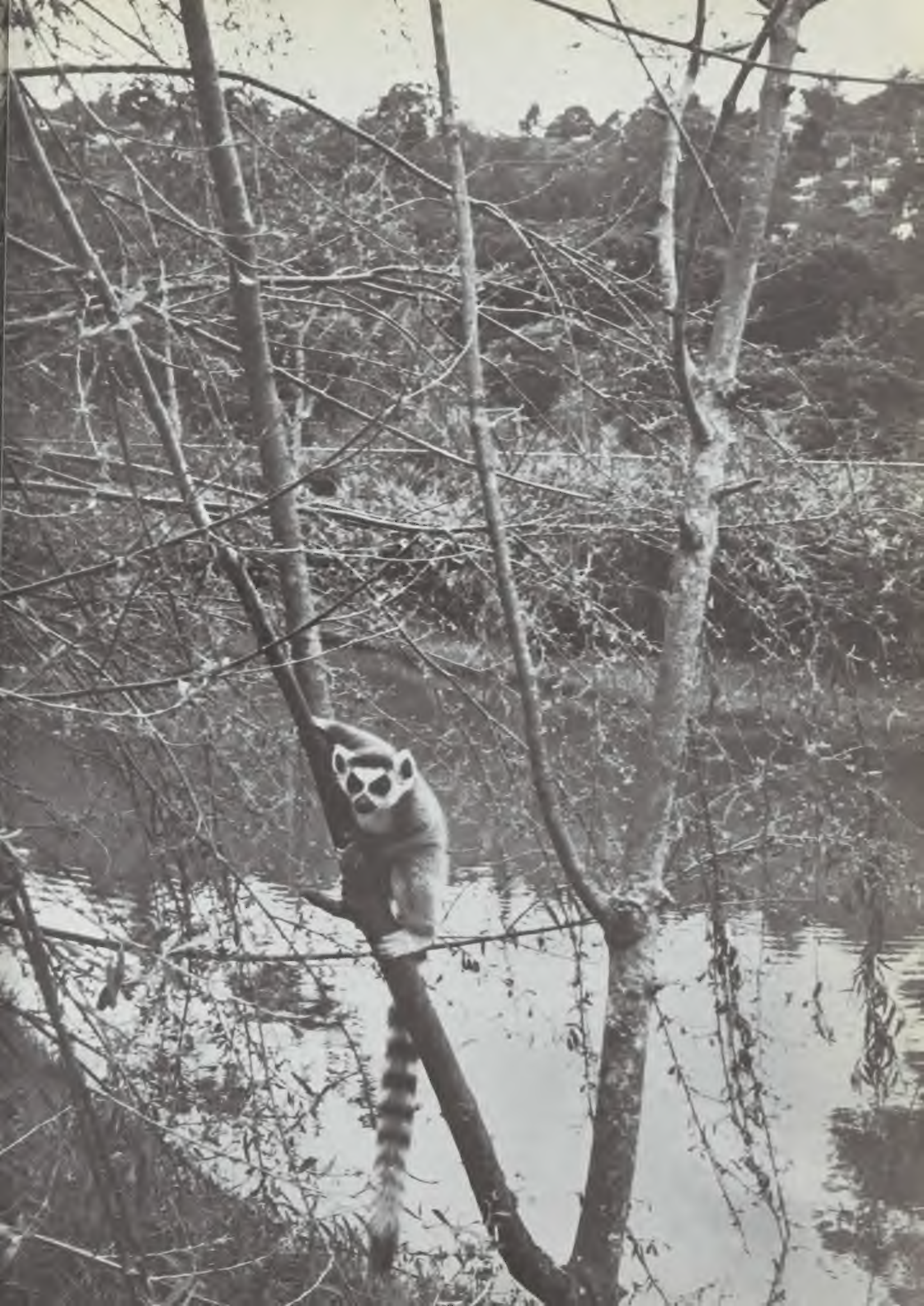
The island, the fourth largest in the world, was once called Lemuria after the lemurs found there. Indeed, these lower primates are found nowhere else in the world but on Madagascar, as are many other strange, interesting, and appealing animals, such as the insectivorous tenrecs and the not-so-handsome but intriguing aye-aye *(Daubentonia madagascariensis),* a close relative of the lemur.

In our walk through Tsimbazaza, we first enter the eastern gate, off Avenue Jean Assolant, and passing a cage of guinea fowl (E)* on our right, we come to two fossas, Madagascan civets, on the left (D). They are in their dens, but as we approach, they dart out nervously and perch on a fallen tree

**Letters in parenthesis refer to the map of Tsimbazaza Park on page 18.*

Lemurs are found only on the island of Madagascar. Twenty-three species and subspecies of these lower primates are exhibited in Tsimbazaza Park, among them the mongoose lemur, *Lemur mongoz coronatus* (at left).

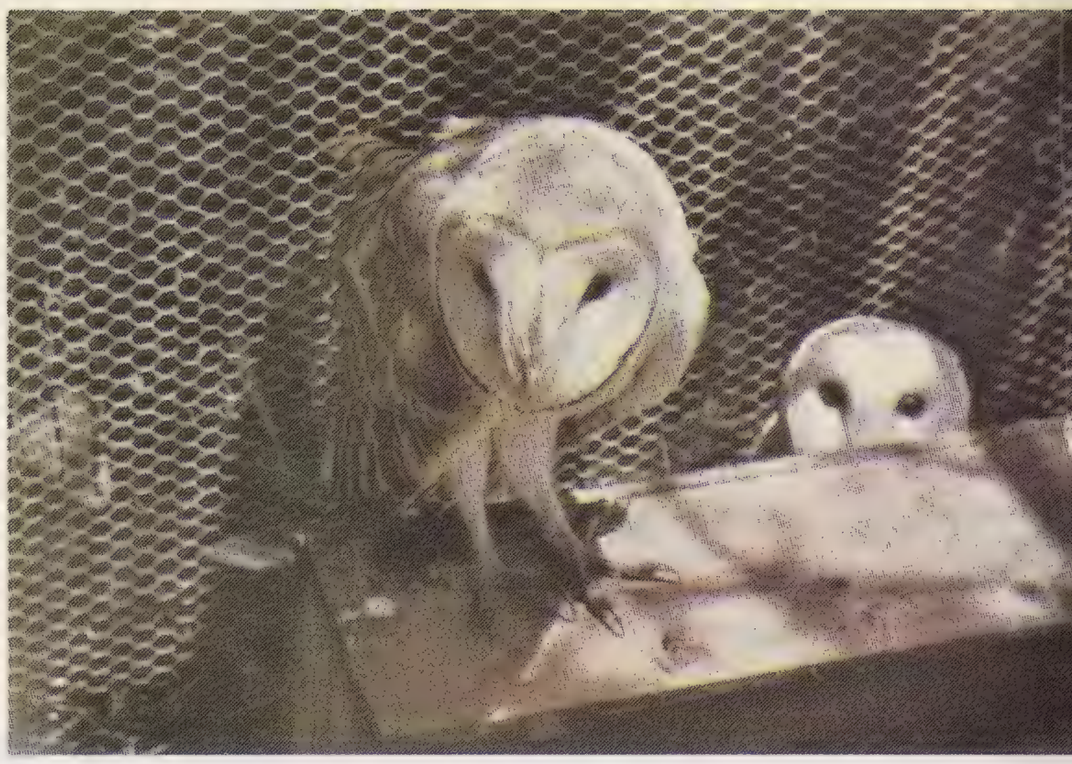
Several ringtails, the most common species of lemur, live uncaged on a small island in the park (at right).



trunk, their eyes open wide in anticipation, curiosity, and apprehension. In addition to man, the fossa *(Cryptoprocta ferox)* is the island's largest carnivore, with a body six-and-one-half feet long, including two feet of tail. In the wild, the fossa feeds on the blood of chickens and accepts rats as part of its diet; it will try to catch a lemur napping on a low branch of a tree. In captivity the fossa is fed a daily diet of 600 grams of zebu beef, birds, and rats. When born it has a gray pelt and chestnut-colored eyes; as an adult its fur becomes a silky brown.

With two white, pear-shaped faces of barn owls *(Tyto alba affinis)* staring goggle-eyed at us from their bailiwick on one side of the path (C), we cross to examine one of the several lemur cages in the park (A). These cages contain the ringtailed lemur *(Lemur catta),* several races of the black lemur *(Lemur macaco macaco, Lemur macaco rufus,* and *Lemur macaco collaris),* and the gray gentle lemur *(Hapalemur griseus).* Lemurs, I hastily add, are not monkeys, although in French they are referred to, casually, as "singes."

Perhaps one of the most amusing-looking lemurs is the *Lemur macaco macaco,* with – I hesitate to say – a slightly hippie appearance, due to its ruffled hair-do. This gentle animal is small, has an oversized head, is wide-eyed, and, literally, bushy-tailed. The male is totally black; the female is brown, white, and yellowish-white.



Barn owls range worldwide, except for the extreme north and some Pacific islands. A subspecies, *Tyto alba affinis,* is found on Madagascar (above).

Some 36 species of chameleons are native to the island. The specimen at right was found in the garden of the U.S. Embassy Residence in Tananarive.

Tsimbazaza Park contains several lakes which present vistas of quiet water and tropical foliage (below).

The *Lemur macaco rufus* and *Lemur macaco collaris* are very similar, with the exception of a black snout in the former. They are both friendly to people and not overactive. The gray gentle lemur *(Hapalemur griseus)* looks as though it had a sense of humor and wonders whether you do. It is a sleepy nocturnal clown that prefers to rest but will perform diurnal antics if disturbed.

The most common lemur is the ringtailed lemur. Ringtails trail in groups of about a dozen, leaping 12 feet to 15 feet from tree to tree. They

sit upright on the branches, sunning themselves, exposing their snow-white stomach to the mid-day sun's heat. Ringtails are playful, bounding back and forth on the ground in mock attack, then stalking off, their question-mark tails swaying with their stride. Stopping to nibble the end-buds off a eucalyptus or jacaranda, they then head for their favorite foods, mango and bamboo leaves.

The ringtail has four calls, or ways of speaking. The first, most frequently used, is a cat-like purr (hence its name, *Lemur catta)*, accentuated by clicks. This signifies recognition, pleasure, or mild excitement. The second is a sharp bark of alarm. The last two are like the meow of a cat: one as a signal for movement from one area to another, and a louder one, indicating acute fear. However, there are other forms of communication, principally olfactory, tactile, and visual.

Tail-marking is a ringtail's favorite pastime. The ringtail has two scent glands, one on each arm above the wrist. In tail-marking the ringtail throws its boa-like tail over its shoulder, then draws it down between its arms. A scent is placed on the tail by the glands. When the ringtail communicates, and particularly when mating, its tail moves abruptly back and forth wafting a scent toward the other lemur. A lemur also will mark branches of a tree, a manifestation of territoriality. Aggressive behavior is signaled by the ringtail staring, with sideways moves of the tail instead of back-and-forth. The lemur's ears are back, its mouth open, and it barks or meows.

At Tsimbazaza some of the 23 species and subspecies of lemurs exhibited live uncaged. An island is the home of seven ringtails *(Lemur catta),* and four black lemurs *(Lemur macaco fulvus)* live on another. A rowboat makes daily trips to the islands with supplies. A third island, 12 feet by 150 feet (R1), is inhabited by two pair of Madagascar ringtailed mongooses *(Galida elegans),* whose territorial habits are being studied by Roland Albignac, director of the park.

The mongoose lemur on page 14 is a primate; the Madagascar ringtailed mongoose, *Galida elegans* (below), is a carnivore. Mongooses range from southern Europe and Asia to Africa and Madagascar.

Turning toward the Vivarium (S), we pass new lemur cages being built in the form of a horseshoe, allowing public viewing from all sides. This construction was made possible by a gift from the New York Zoological Society.

Tsimbazaza does not have the large indri, an animal related to the lemur and erroneously believed by early settlers on the island to have been a man. Another member of the family Indriidae, and therefore also related to the lemur, is the sifaka *(Propithecus verreauxi).* A snowy-white beauty, the animal has a distinctive black head. In the wild they live in groups of about 15 individuals. They leap from branch to branch with aeronavigational ability and grace, covering distances of up to 30 feet. A sifaka bears only one young at a time, normally in September.

I have already referred to the not-so-handsome aye-aye *(Daubentonia madagascariensis).* The park has two of them (T). There are estimated to be no more than 50 aye-ayes on Madagascar, 12 of which have been placed in protective custody on the island reserve of Nossi Mangabe, near Maroantsetra, off the northeastern coast. This unique beast is most nearly related to the lemur. It has been described as having the teeth of a rabbit, the ears of a bat, the fur of a wild boar, the hands of a monkey, and the tail of a fox. The aye-aye is strictly nocturnal. At Tsimbazaza, about 5:30 P.M. daily, the creature surfaces from its burrow of mango leaves and exercises about its cage.

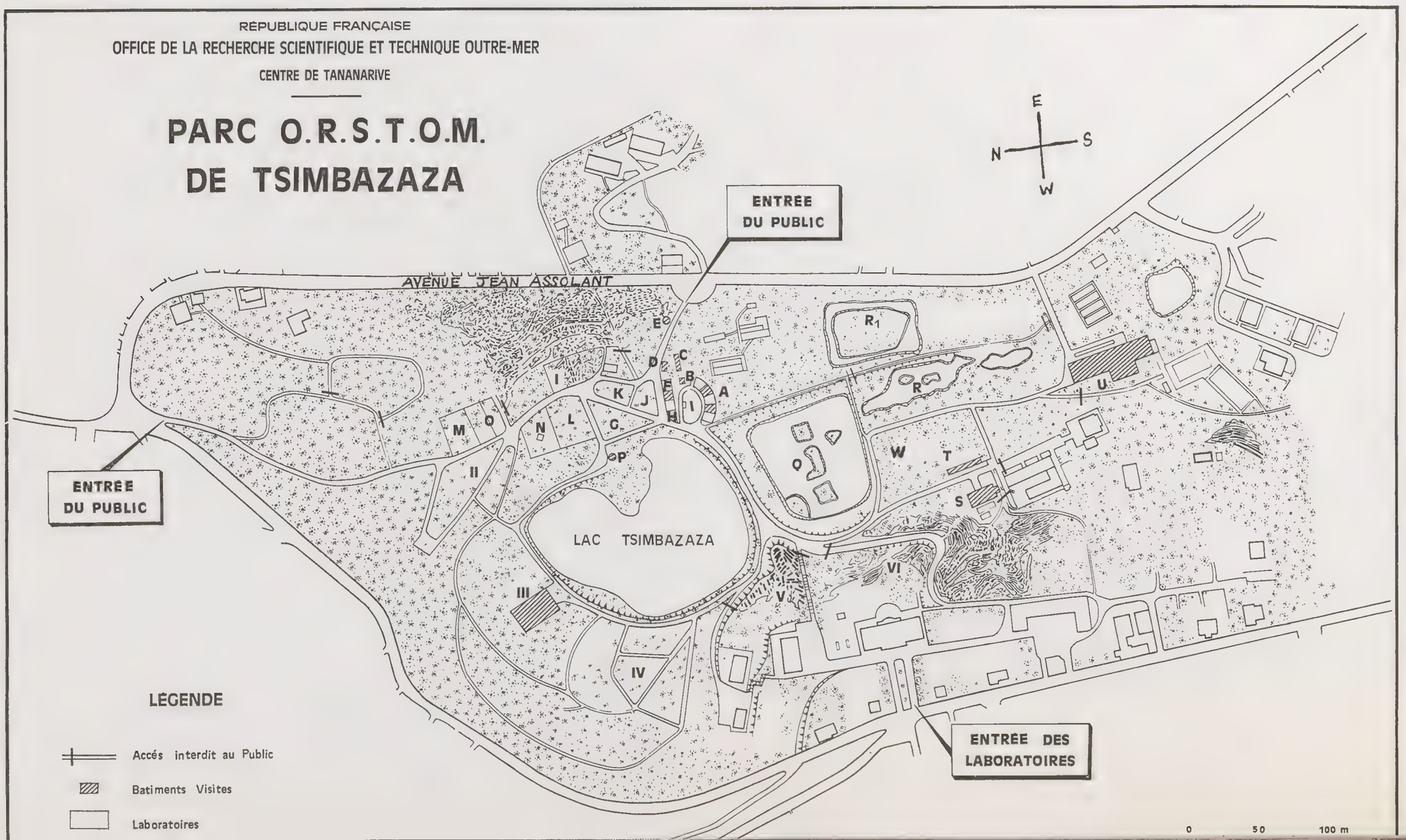
One of the aye-aye's outstanding features is an extraordinarily long and twig-like third finger which it uses to penetrate holes in trees for larvae, after first tapping gently on the wood to find the

After locating insect larvae by tapping with its specialized third finger, the aye-aye gnaws down to the burrow with its chisel-like teeth.

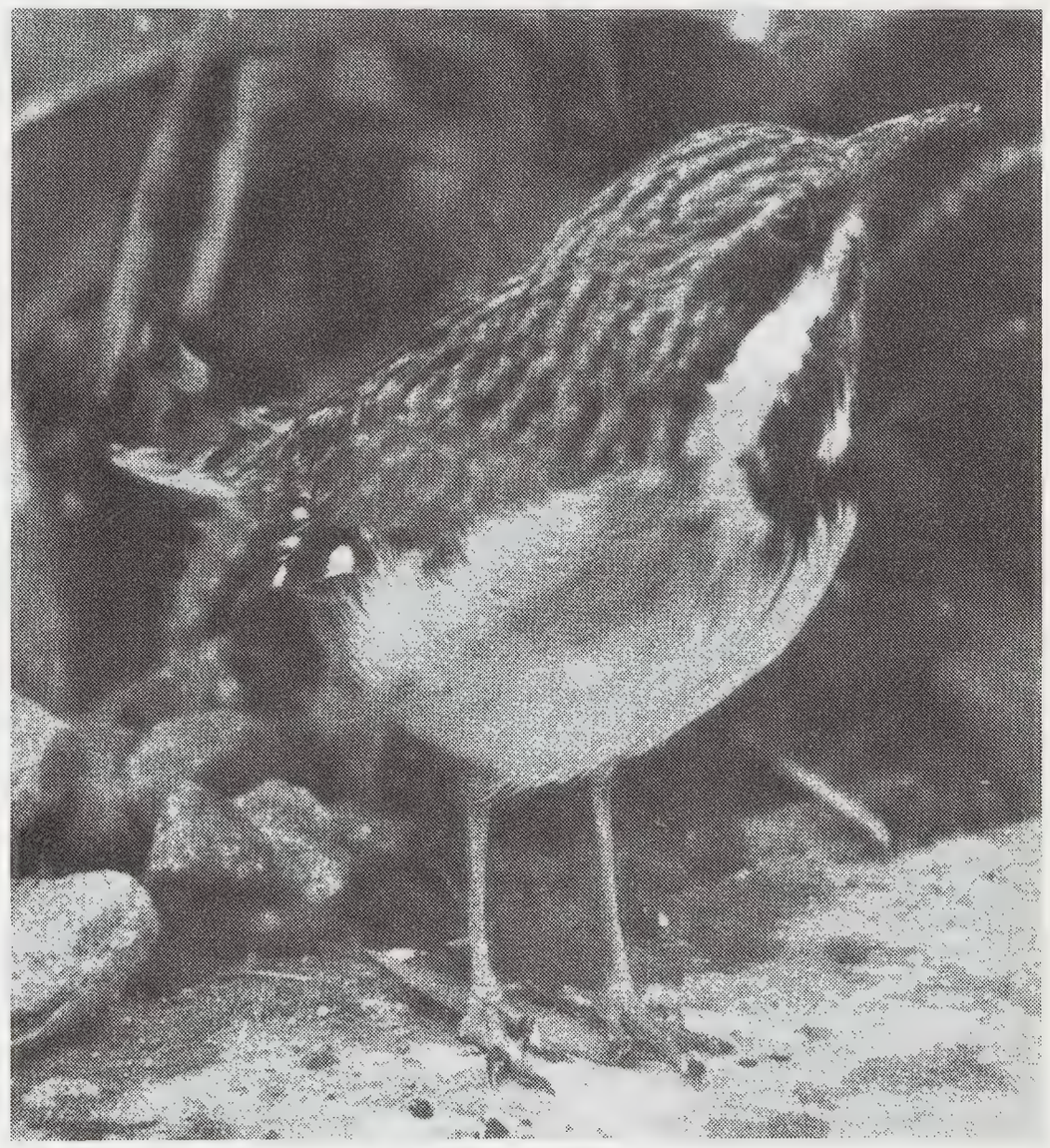
right place. The aye-aye's diet also includes bird eggs, the pulp of coconuts, and sugar-cane stalks. In captivity it accepts eggs, bananas, and honey.

To the list of mammals indigenous to Madagascar must be added the seven genera of nesomyine rats, which generally are of a calm and tranquil nature. Other less friendly rats (two principal species, *Rattus norvegicus* and *Rattus rattus*) have been introduced.

I have seen numbers of bats in Madagascar; there are, in fact 26 species, generally found all over the island. I have watched bats on the small island of Tanikely, near Nossi Be, and in a forest reserve near Amboasary, 110 kilometers from Fort Dauphin in southern Madagascar. Bats are found in considerable numbers on inland islands and along rivers. A huge population of bats lives in vast, mosquito-infested underground caves in north-



There are five species of ground-rollers, all native only to Madagascar. Four species live on the floor of the rain forest, but the 18-inch long-tailed ground-roller (below) is found exclusively in the arid southwestern part of the island.



western Madagascar (Andavakoera Massive), where they have deposited a mass of guano 15-feet to 18-feet thick, representing several thousand tons.

The economic officer at the United States Embassy waited patiently each year for the hunting season of the African bush pig *(Potamochaerus larvatus)* (K). Usually found in bands of ten to 15 animals, a full-grown male bush pig can weigh 150 pounds. Like so many animals in Madagascar, the bush pig is considered by many of the local residents to be *fady,* that is, sacred or magical.

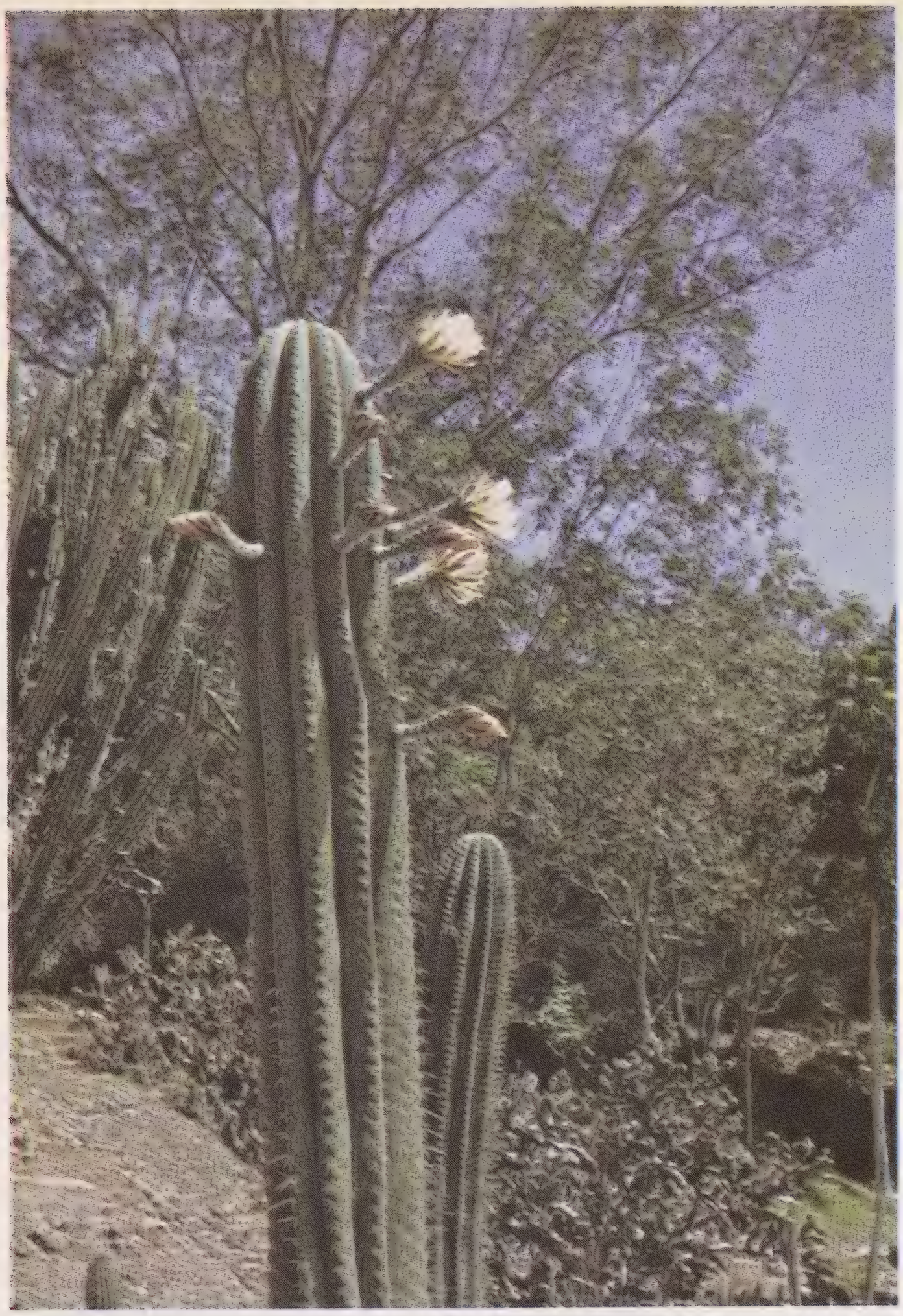
A visit to the Vivarium gives one a chance to meet some insectivores, such as the nocturnal, but prolific, tenrec. The tenrec lives in the forest, bearing up to 16 young at a time. Considered a delicacy by the Malagasy and some Europeans, the tenrec has even been bred for the ultimate destination of the kitchen.

Also housed in the Vivarium is the Madagascar ringtailed mongoose *(Galidia elegans),* an appealing, brownish-red animal, curious, nervous and active. Only a foot-and-a-half long, it is very hard to see in its natural habitat. It lives predominantly on the east coast of the island. Other Malagasy carnivores include the nocturnal fanaloka *(Fossa fossa),* a civet whose diet consists mainly of insect larvae, frogs, and an occasional chameleon.

The Vivarium is also the home of several chameleons, geckos, and birds. There are 182 species of birds on Madagascar of which 65 percent are endemic, or native to the island. The long-tailed ground-roller *(Uratelornis chimaera)* is a particularly rare and attractive bird found exclusively in the Morombe region of southwestern Madagascar.

An outstanding feature of the park are several islands on its largest lake, which are used as a seasonal rookery by eight species of birds, predominantly herons, egrets, and ibises. In February, the full nesting season, as many as 5,000 birds gather on the islands with the Queen's Palace on the height of the hill in the background. The main O.R.S.T.O.M. building looks down from a hill on

The generic name *Lemur* was coined from the Latin *lemures* for the "ghostly" appearance of the faces and nocturnal habits of these primates. Shown below is a male black lemur, *Lemur macaco collaris.*



An American cactus flowers in a park garden on an island off the southeastern coast of Africa.

the other side onto the rookery.

In rounding out our walk with nature in Madagascar, we must not ignore the flora, which comprises a considerable part of Tsimbazaza's attraction. There are three separate and extensive cactus gardens — Malagasy, American, and African. A variety of palms, including the traveller's palm which is Madagascar's national symbol, line the border of an attractive lake, and an arboretum shelters young plants and vines. The park has an orchid house containing a fine sampling of the 1,200 species unique to the island.

Also on the park grounds is a museum which includes a natural history section. The skeleton of an *Aepyornis,* a bird larger than an ostrich which became extinct only 300 years ago, is on display along with its egg. About 80 whole eggs have been found to date, with one or two eggs surfacing from river beds in southern Madagascar each year and sold to collectors at prices in excess of $1,000 each. A well-displayed collection of butterflies and moths covers one wall, including a stridulant that "communicates" by rubbing its wings, and the large, yellow "comet," with its trailing "tails."

Madagascar was originally part of the ancient continent of Gondwanaland, which is the name of a hypothetical land mass in the Southern Hemisphere which separated near the end of the Paleozoic, over 225 million years ago, to form South America, Africa, and Australia. Some links have been established between species of flora found in both Madagascar and New Caledonia, an island in the southwestern Pacific Ocean about 800 miles east of Australia. Strangely enough there are comparatively few similarities between the flora of Madagascar and that of Africa. The entire 18 genera of Madagascan palms, for instance, which belong to the Areceae, are not found in Africa. Only two of the 120 native palms are not endemic. There are 7,370 species, 191 families, and 1,289 genera of flowering plants in Madagascar, of which 5,820 species, or 86 percent, are strictly endemic, the highest for any geographic area in the world.

Madagascar, indeed, is different.

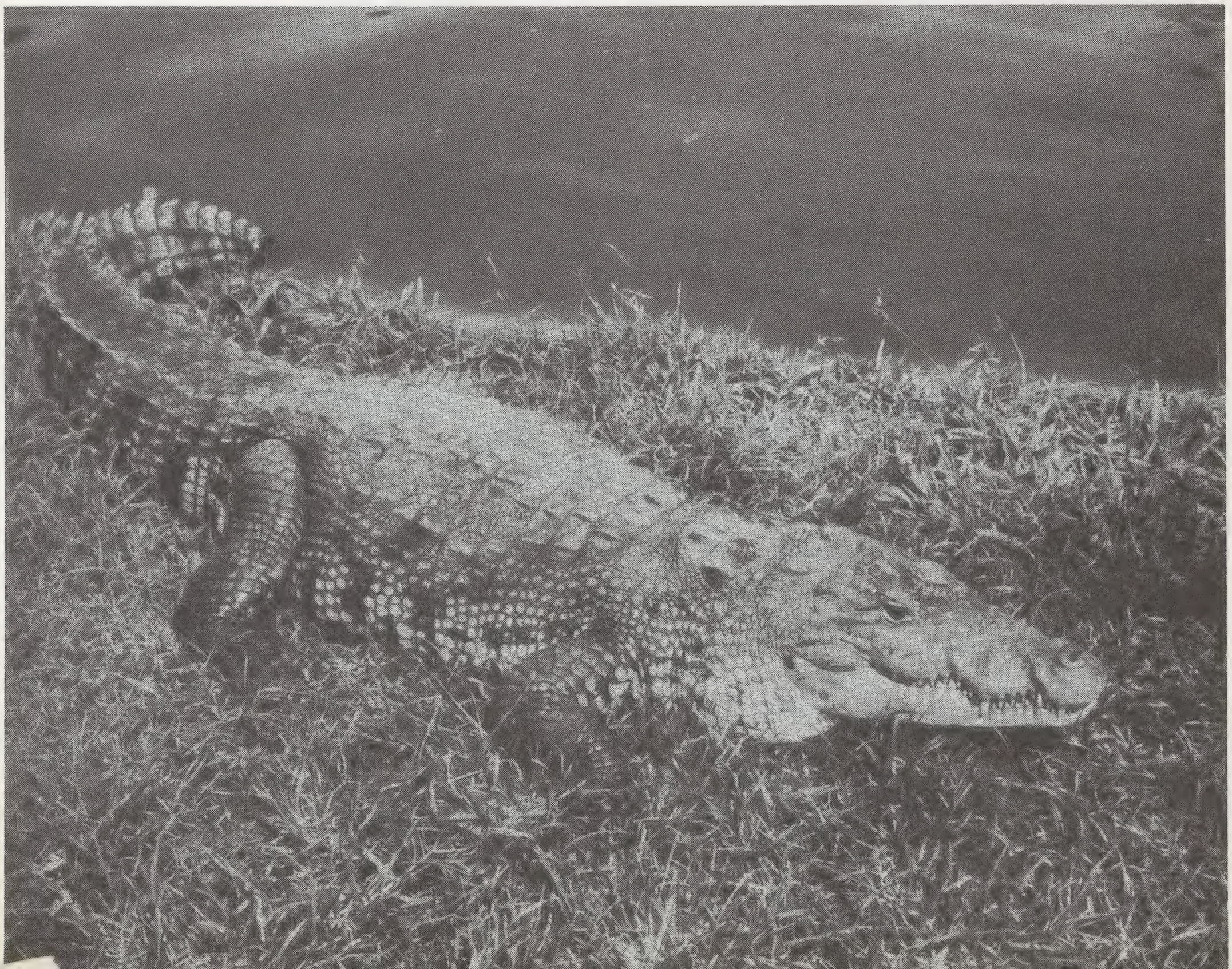
James Powell

The Morelet's Crocodile

An Unknown Quantity

I do not know much about the Morelet's crocodile *(Crocodylus moreleti).* Nobody knows much about the Morelet's crocodile. During six years of research in the field and the library, I have learned a little, which I would like to summarize before I find myself writing about a fossil species. I had better hurry.

Before its decimation by hide hunters, the Morelet's crocodile was by no means rare, yet its existence was not confirmed for science until 1923—a fact which should cause a moment's reflection among those who assert the world is now too well explored to harbor major zoological discoveries. Actually, like the New World, the Morelet's crocodile underwent a series of discoveries and re-discoveries, with Karl Schmidt as its final Columbus. It was well known to the Mayans and, like the Nile crocodile *(Crocodylus niloticus)* in ancient Egypt, was revered as a sacred animal; its stylized likeness often adorns the temples of these master zoologists of American antiquity. To the succeeding Aztec civilization, it was *acuetzpalin,* though this term referred to crocodilians in general and was also applied to the American slender-snouted crocodile *(Crocodylus acutus)* and the Central American caiman *(Caiman crocodilus fuscus).*



The modern history of the Morelet's crocodile begins in 1851, when Duméril, the French naturalist, described a new species of crocodile from the Petén of Guatemala, naming it after its discoverer, P. M. A. Morelet, an animal collector. By 1870 additional specimens had been collected from the vicinity of Belize, British Honduras, and from the Polochic River in eastern Guatemala; and in that year the species was re-described by Duméril and Bocourt in their *Mission Scientifique au Mexique.* Yet for five decades *Crocodylus moreleti* hung in a kind of scientific limbo, regarded as either a variant of the American crocodile, or as a case of confusion with the Cuban crocodile *(Crocodylus rhombifer).* Then, in 1923, Karl Schmidt, herpetologist and zoogeographer, collected a series of specimens from the Sibun Swamp west of Belize, and the species' zoological probation was over. *Crocodylus moreleti* was alive and well in the Sibun.

And elsewhere—though exactly where is still conjectural, for the range of Morelet's crocodile is imperfectly known. Wherever suitable habitat occurs—and where it has not been exterminated by man—it is found throughout British Honduras; in the Izabal, Alta Verapaz, and Petén departments of Guatemala; and in Mexico, on the Yucatán Peninsula, the interior basin and northeastern jungles of Chiapas, and the vast swamps of the Tabasco coastal plain, thence north along the Gulf coast to southern Tamaulipas. The northernmost record is a juvenile specimen, collected in 1903 by S. E. Meek, from Forlón, Tamaulipas—approximately 23°, 17' N. lat., or just south of the Tropic of Cancer. More recently, on May 20, 1949, another juvenile was collected five miles west of El Limón, Tamaulipas, at about 22°, 51' N. lat. It has been reported from the Soto la Marina River, 23°, 45' N. lat., but there are no official records. Records are likewise lacking from the northern, or Caribbean, coast of Honduras; and as Schmidt failed to find the species in the inland lakes of this region, it probably does not occur there.

It does occur on the Pacific coast of Guatemala and Chiapas, Mexico — a distribution sometimes treated as controversial even in quite recent literature. How far northwest into Mexico this Pacific population may extend, or whether it also extends southeast into El Salvador, is not known.

As crocodiles go, the Morelet's is a small species, but large individuals almost certainly exceed the eight feet usually given as the maximum length. There is a 43-centimeter (approximately 17 inches) skull from the Usumacinta River in the Senkenberg Museum at Frankfort-am-Main, and I have personally measured two skulls of similar dimensions in southern Tamaulipas. Using Schmidt's rule-of-thumb that a crocodilian is roughly eight times the length of its skull would give a maximum size of around 12 feet—still small compared with the 23-foot record for the American crocodile, but an imposing reptile, nevertheless.

The Morelet's crocodile is a geographically variable species. Adults vary considerably in their coloration, though whether such differences are regional or merely individual is uncertain. Schmidt, writing of the Belize specimens, remarked that in those over a meter long, the characteristic juvenile markings of transverse black bands on an olive background were virtually obliterated by a uniformly dark color on the back and sides. This dark phase may well be typical of British Honduras. Meanwhile, in Yucatan I have seen eight-foot individuals in which the juvenile markings were still distinct.

More significant is the variation in snout shape. Numerous characteristics set the Morelet's crocodile off from the American crocodile: its dorsal scales are more numerous, less regularly arranged, and less strongly keeled than those of its gigantic relative; while the scales covering the upper sides of its limbs are smooth rather than moderately keeled as in the case of the American crocodile. The last difference is probably the easiest and most reliable way of distinguishing between juveniles of the two species. But more than any other feature the broad, massive snout of the Morelet's crocodile separates it from the slender-snouted American form. Yet this distinction, so clear-cut in the species' "heartland" of Guatemala, British Honduras, Yucatán, Chiapas, and Tabasco, becomes less so as one moves north along the Gulf Coast. From northern Veracruz, eastern San Luis Potosí, and southern Tamaulipas, come specimens which might legitimately be classified as either *Crocodylus moreleti* or *Crocodylus acutus,* so evenly do they exhibit the characteristics of both species.

Is the northern form of the Morelet's crocodile a valid subspecies? Does it hybridize with the American crocodile? Do the two forms merge into one? Here is a mystery, and one we may never solve. A statistical study of large numbers of individuals is needed, and large numbers of individuals no longer remain.

Most of the world's crocodilians fit into one of three ecological categories: palustrine forms, char-

acterized by moderate size and broad snouts, and adapted to life in an inland, freshwater environment; estuarine forms, larger and with narrower snouts, and taking freely to salt or brackish water; and the fish-catching, or gavialiform, crocodilians, whose extremely narrow and elongate snouts are ideally designed for swift, sidewise movements in a dense medium. This last group ranges in size from the little *Crocodylus johnstoni* of Australia to the gigantic true gavial *(Gavialis gangeticus)* of India.

The Morelet's crocodile is a palustrine form, with the American crocodile as its estuarine counterpart. But the segregation is tenuous: both species can exploit either a brackish or a freshwater habitat, provided this does not involve competition with the form more specifically adapted to that habitat. The Morelet's crocodile has been recorded from the brackish lagoons off the northern coast of the Yucatán Peninsula, where the American crocodile is not known to occur. Conversely, the American crocodile fills the palustrine niche in the inland lakes of Honduras. Schmidt found it at 2,000 feet above sea level in Lake Yohoa.

In certain areas, such as the Tabasco swamps, it is probable that the two species occur together in the same waters. If so, it would be interesting to speculate on what differences in food preferences separate them. Again, the rarity of individuals of either species make the problem difficult to study. The little work that has been done on stomach contents of Morelet's crocodiles under a meter in length indicates a predominately insect diet, supplemented by crustaceans, fish, vegetable matter, and an occasional turtle or small mammal. The ratio of vertebrates doubtlessly increases in larger individuals, but quantitative data are lacking.

The Morelet's crocodile seems an opportunist when constructing a nest. It exploits whatever materials are available. A captive female in Venezuela's Merida Zoo has bred and laid twice in a sand-floored enclosure devoid of vegetable debris. In both instances she excavated a nest in the sand and covered the eggs with a sand mound after the manner of the American crocodile. Where selection exists, the preferred nest form seems to be a mound of earth and vegetation. In 1967, a nest of this sort was described from Tabasco by R. G. Zubieta; in the recent successful breeding of this species in the Grant Park Zoo in Atlanta, Georgia, a similar construction was observed, the nesting female having been provided with a variety of materials.

Little is known of courtship or breeding. In Mexico, mating probably occurs from the beginning of March until May; the eggs are usually laid from the latter part of April through May. During rut, the male becomes extremely aggressive. The female guards the nest during incubation and is said to escort the hatchlings to the water, though

The narrower, more pointed snout of the American crocodile (below), a species that occasionally may reach a length of over 20 feet, distinguishes it from the smaller Morelet's crocodile, shown on page 21.

A palustrine form, the Morelet's crocodile prefers inland, freshwater habitats. In 1966, this Mexican swamp still harbored a small population of the long snouted, northern form of the species; by 1968, that population had been exterminated.

this last needs confirmation. There are little data on clutch size. The one clutch I have personally observed contained 17 eggs.

As the sole survivors of the subclass Archosauria ("ruling reptiles"), to which the dinosaurs and pterodactyls also belonged, all crocodilians are in a sense "living fossils." But the Morelet's crocodile may be more so than most. The modern genus *Crocodylus* existed in the late Cretaceous; and Karl Schmidt considered the broad-snouted, inland forms such as the Morelet's crocodile, the Cuban crocodile, and the marsh crocodile of India and Ceylon *(Crocodylus palustris)* to be primitive forms, very close to the early Tertiary survivors of the Mesozoic reptile empire. The large, estuarine species he regarded as later radiations.

Historical geology supports Schmidt's view. Living fossils are generally associated with ancient land cores, areas that have been continuously above the sea since remote periods. It is no coincidence that Africa and Australia are such treasure-houses of relict life, or that the ginkgo and the metasequoia grow beside the unsinkable hills of China. Wherever there is a survivor from the past, we may expect to find not too far away a part of the earth that has survived with it.

The palustrine crocodiles illustrate this nicely. Like Africa and Australia, peninsular India is a remnant of Gondwanaland. The Cuban crocodile might seem an exception, for Cuba's geological history has been as turbulent as its political history, and during the Tertiary it ducked in and out of the Caribbean like some colossal porpoise. However, two areas, elevated today into the Sierra de los Organos in Pinar del Rio province and the low mountains north of Trinidad in the province of Las Villas, always remained afloat as low islands. On the first grows an endemic cycad; not far from the second is the Zapata Swamp and Cuba's relict crocodile.

The range of the Morelet's crocodile lies peripheral to nuclear Central America. This region, consisting roughly of northern Nicaragua, most of Honduras and El Salvador, the highlands of Guatemala, and parts of Chiapas, forms the western end

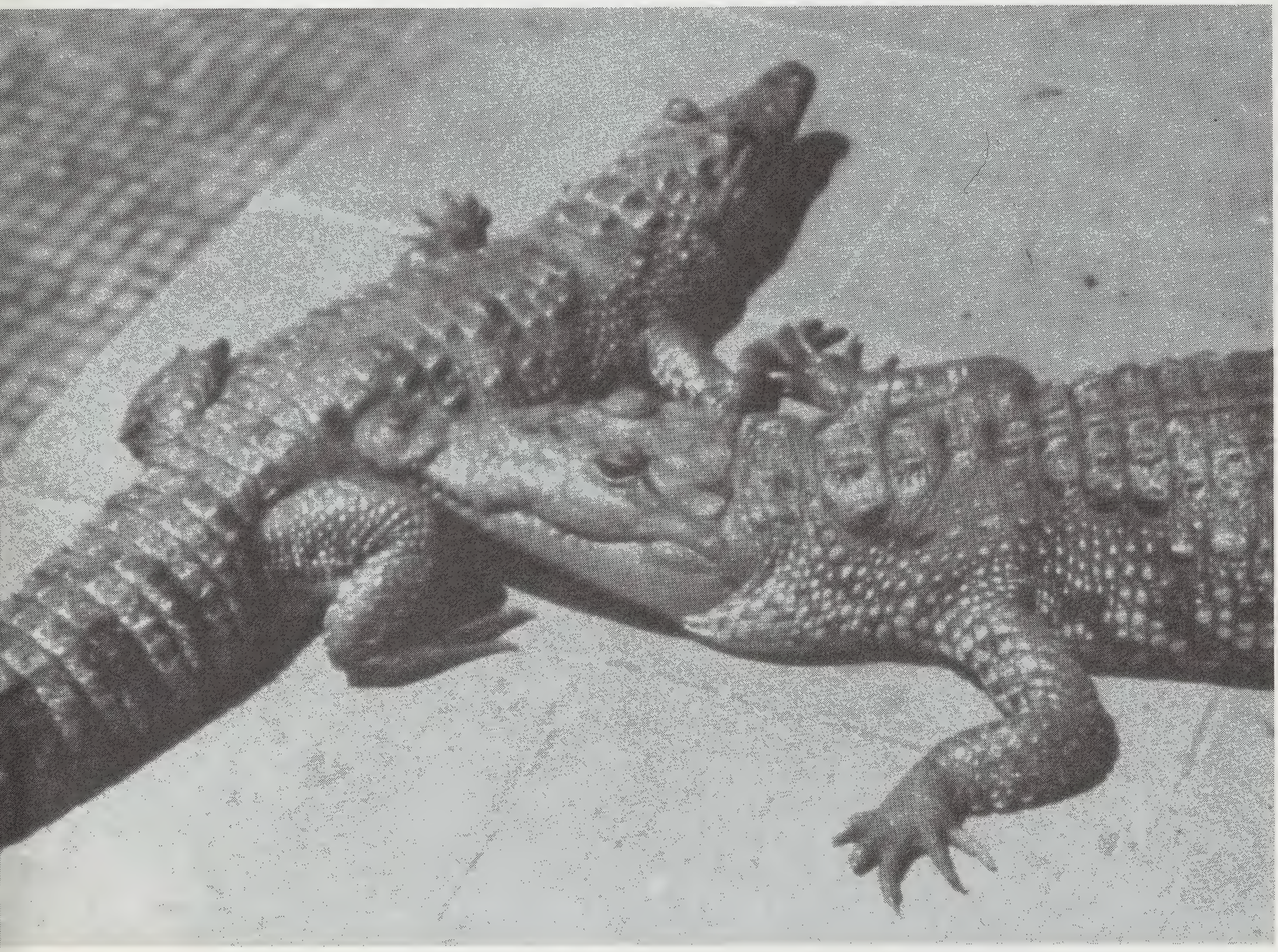
of the Antillean Geanticline; and for all its recent volcanism, it is one of the oldest land areas on earth. Shorelines have fluctuated, but at no time since the Jurassic has any great portion of it been under the ocean at any one time. Parts may even date from the Pre-Cambrian.

Nor does the Morelet's crocodile lack for Mesozoic company. Cycads, the dominant plants of the Age of Reptiles, range from Honduras northward into Mexico with a richness unrivalled in the modern world, and the Central American river turtle *(Dermatomys mawi)* is the lone survivor of a family widespread during the Cretaceous.

The tragedy of the great Age of Dinosaurs was not that it ended, but that it ended seventy million years before intelligent beings evolved who could appreciate its magnificence. The perennial popularity of the "Lost World" school of science fiction illustrates the hold which the great reptile empire of the Mesozoic has on the public imagination. How absurd, then, that we should dedicate ourselves to the extermination of the nearest thing to a·live dinosaur we shall ever have this side of a time machine. And as Edwin H. Colbert points out, the largest of the living crocodilians are of no mean size when compared with some of the large dinosaurs. Certain extinct crocodilian forms were even bigger. The 45-foot *Phobosuchus* of the late Cretaceous was as large as the *Tyrannosaurus rex,* and the gavial-like *Rhamphosuchus* of the Pliocene of India may have reached 60 feet. Thus, the largest carnivorous reptile yet discovered was not a dinosaur, nor even from the Mesozoic, but a gigantic crocodilian from the late Tertiary.

So the age of great reptiles need not be over unless we make it so. Unfortunately, we are making it so with dismal efficiency. In this new great dying, the Morelet's crocodile has suffered more than most of its kind, if only because its restricted range makes it more vulnerable than a widespread species such as the American crocodile. In British Honduras it has no legal protection. There is legal protection in Guatemala and Mexico, but until very recently such protection was purely nominal. A hide-hunter could openly shoot and sell without fear of prosecution.

The four-foot long Morelet's crocodiles shown below are on exhibit in the Palacio Municipal (City Hall) of Villahermosa, Tabasco, in Mexico.

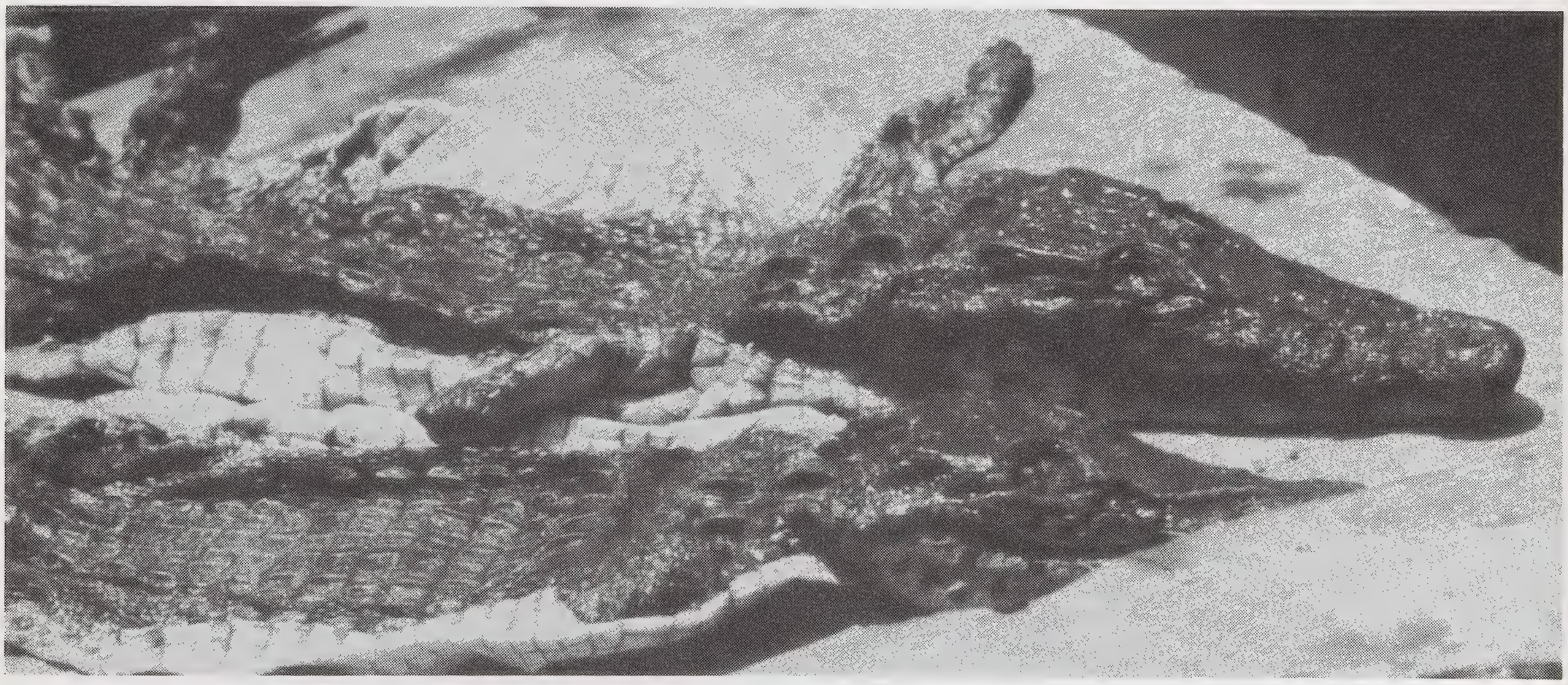


Today, the status of the Morelet's crocodile varies from rare to non-existent throughout its range. It is almost gone from the Sibun Swamp of British Honduras; with luck, a local fisherman may twice a year glimpse the little crocodilian whose existence was there first confirmed for science less than 50 years ago. Undisturbed populations may still exist in the remote vastness of the Lacandon jungles of northeastern Chiapas, but elsewhere the species stands poised to return to the shadows from which it so recently emerged. The International Union for the Conservation of Nature and Natural Resources and the World Wildlife Fund list it as critically endangered. The New York Zoological Society labels it a vanishing animal.

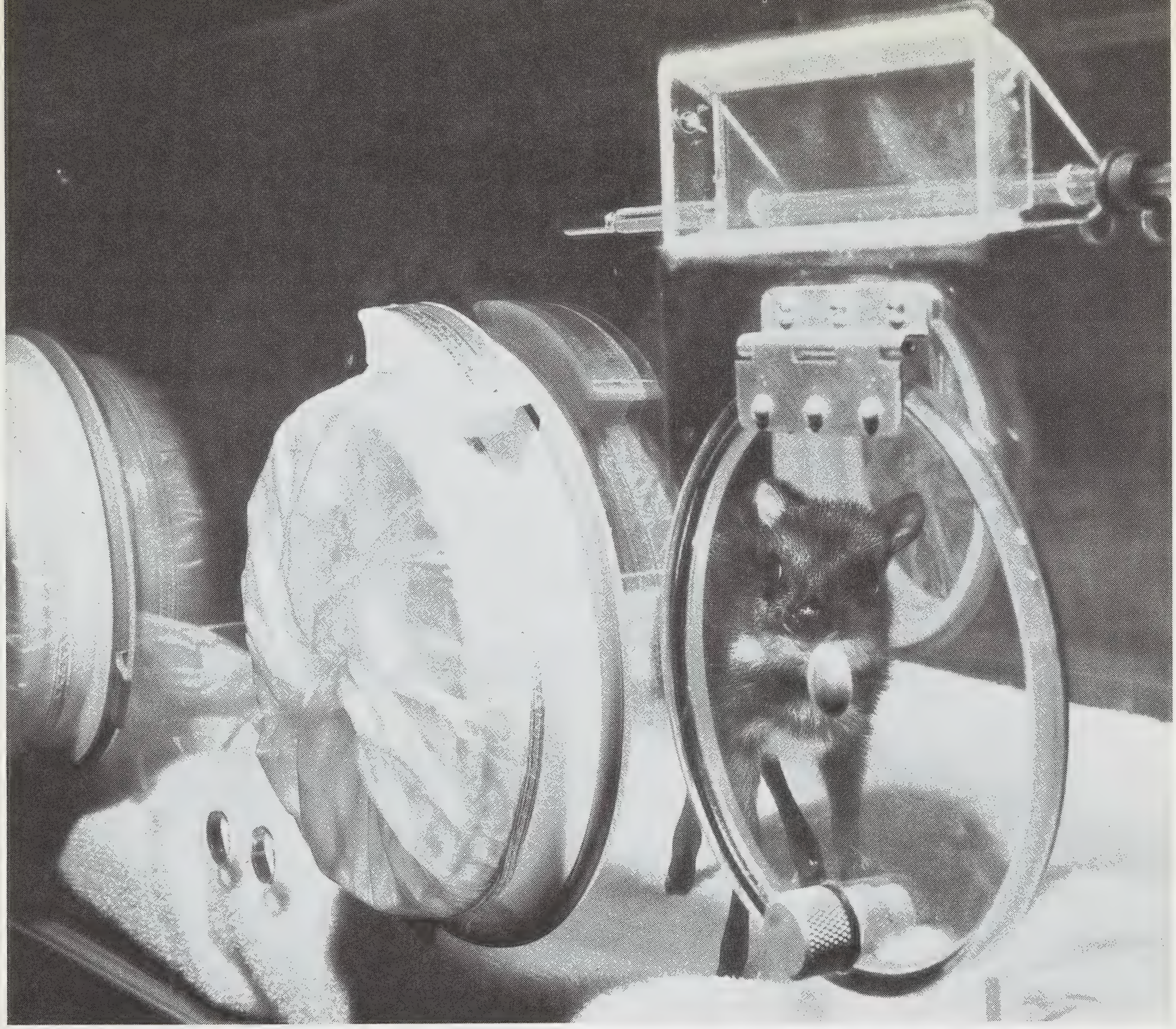
There is hope. Perhaps because of New York State's Mason Act and similar laws in the United States which have diminished the market value for crocodilian products, perhaps because of a new effort on the part of at least some of the governments involved to protect their crocodilians, perhaps because of both, the Morelet's crocodile may be making a tenuous comeback. It is too early for complacency or even optimism, but Dr. Howard Campbell of the University of Florida recently sighted a number of adult specimens in the Papaloapan River of Veracruz. Meanwhile, the local poachers complained that their business was becoming an increasingly risky one.

A captive breeding and field-study station for the Morelet's crocodile, financed in part by the Mexican government and in part by World Wildlife Fund grants, has been established on the Pacific side of Chiapas. Among its projects has been a field survey of crocodilians in Chiapas and adjacent parts of southeastern Mexico. There is another captive breeding station, under the direction of Dr. Miguel Alvarez del Toro, at the zoo in Tuxtla Gutiérrez.

Such breeding stations are a valid part of conservation, yet they must remain at best supplementary. A captive gene pool is a lesser evil than extinction, but it is a sorry substitute for a wild population. In the case of Morelet's crocodile, wild populations do exist and would recover if unmolested. Crocodilians are resilient creatures. The resiliency which carried them through the reptilian doomsday at the end of the Cretaceous will carry them through again if given half a chance. And half a chance does not seem too much to ask for the sole survivors of the most spectacular land fauna the world has ever seen.



Fresh skins were found in a Mexican hide shop in 1969 (above); however, in 1970, no new hides has been brought in for sale, an indication of the probable extinction of Morelet's crocodile from the region.



Emil P. Dolensek

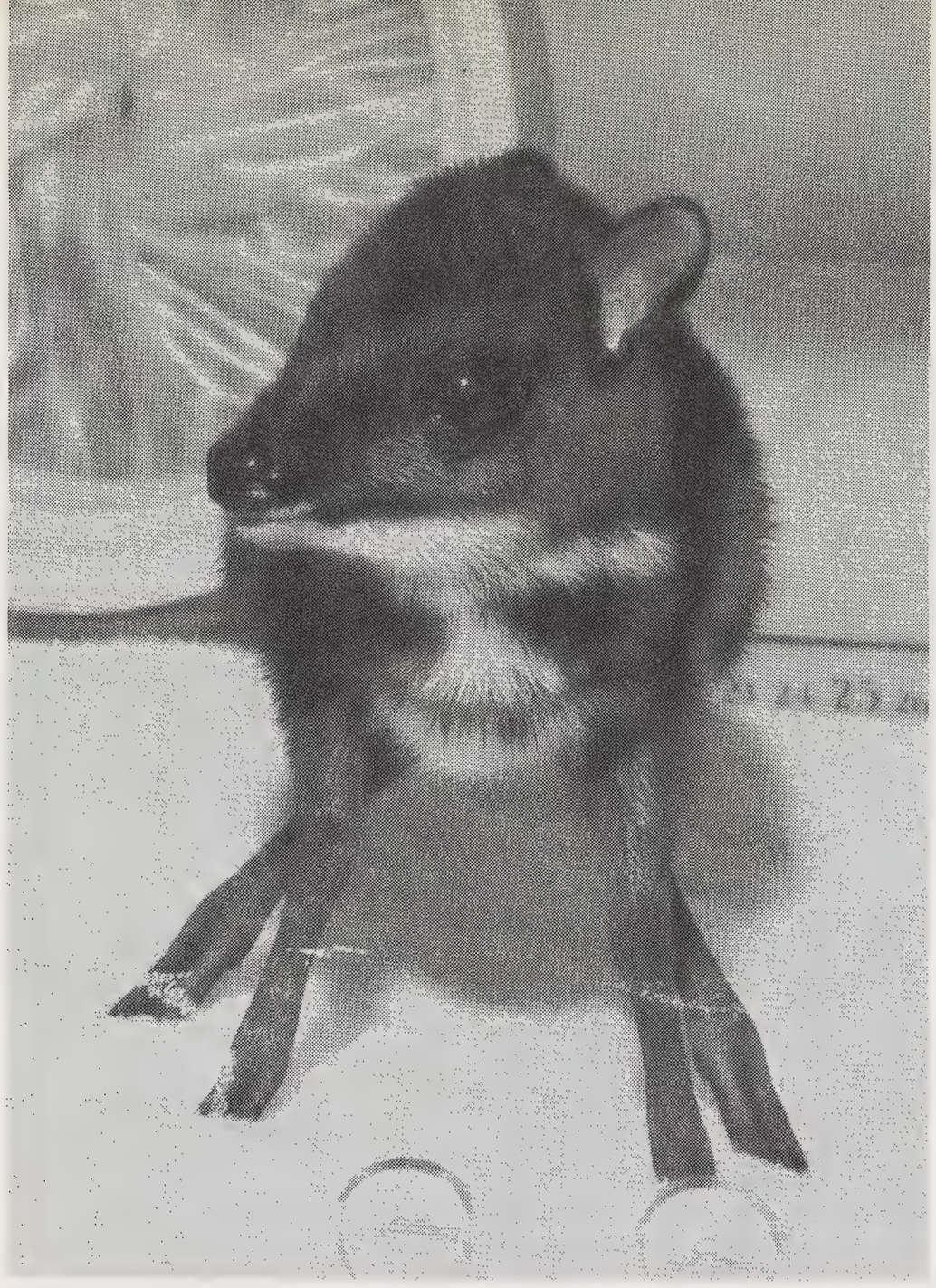
The Bronx Zoo's Veterinarian Reports on an Addition

The New Animal Nursery

A baby mouse deer, an extremely delicate animal, that was rejected by its mother, was placed in an incubator in the new nursery (above).

Many people, at one time or another, have thought it might be fun to rear a young wild animal. What most people fail to realize, however, is that wild animal infants cannot be cared for merely at one's whim. Not unlike human infants, they must be fed and watched around the clock. A specific diet must be formulated for the particular species being reared, and one must record how much the animal consumes at each meal and the infant's weight gains or losses. All this means that to raise a young wild animal, one must rearrange his life to suit the needs of the animal. At best, this is not an easy task.

At the Bronx Zoo, an animal is hand-reared only when it is necessary for its survival. Animals are left motherless for varying reasons, the most common one being rejection by the



Small baby animals require special care in handling and feeding. The mouse deer is removed from the incubator and fed from a doll's baby bottle (at right). A red brocket deer, quartered in a playpen, can take a larger bottle (bottom, right).

mother. Not all wild animals are naturally good mothers. A wild animal mother may ignore her young, especially in the case of first-born offspring, because of inexperience. If an animal is sickly when it is born, it is rejected by its mother.

Formerly, when an animal was orphaned at the Bronx Zoo, many practical as well as medical problems arose. A volunteer had to be found from among the staff to care for the animal,and a place suitable for rearing it had to be found, since there was no spot in the zoo specially equipped for this purpose. To meet this need, a nursery was constructed in the zoo's animal hospital.

A room in the hospital was redesigned to have a controlled flow of air so that the environmental factors would be constant. Two baby incubators were installed for animals that are born prematurely or otherwise especially weak. An area for preparation of infant formula was included, stocking the usual array of bottles and nipples. And, of course, our nursery needed a playpen.

As important as the physical facility for raising young animals is developing understanding of their highly specialized and dietary needs. The diet for each species must be geared according to its own particular nutritional needs, and the amount of food an animal is fed must be watched carefully.

Shortly after completion of the nursery, we were presented with Susie, a 12-pound guanaco. The normal weight at birth for this animal is generally between 22 pounds and 24 pounds. Because of her general weakness and poor control of her limbs, Susie failed to nurse. As she was too weak to take a bottle, feeding was accomplished through a stomach tube for the first days of her life. Her diet consisted of cow's milk enriched with egg yolk. As she became stronger, Susie gradually showed more and more interest in the bottle, and after a month she was taken off medication. She remained in the hospital until she was large enough and strong enough to return to the herd.

Although she is now with the rest of the herd, Susie has not forgotten the human "mothers" who cared for her. If any one of the hospital staff who cared for her wanders into the field where she lives and calls to her, she comes running and gives them a contented nudge.

Not long after Susie came into the nursery, Lhasa, a baby yak arrived. Lhasa's mother showed no interest in nursing or caring for her. She was much stronger than Susie had been and had no problem nursing from a bottle. A diet of cow's milk was used until she was old enough to handle solid food. Lhasa has also been returned to her herd, but she also never fails to recognize her nursery "mothers."

Visiting with us now is Carlos, a confiscated mountain lion cub, which arrived undernourished and suffering from a skin condition. Both of those problems have been overcome, and Carlos now spends his days stalking the halls of the hospital and attacking the legs of passing hospital staffers.

Of course, not all of our stories are success stories. But, under the good conditions now available, our increasing knowledge of proper diet,and specifically trained personnel, the orphaned animal now stands its best possible chance of survival.

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animal kingdom REPORTS

WHAT CAN YOU DO FOR CONSERVATION?

Recycle your knowledge of animals and ecology by joining the volunteer guides at the Bronx Zoo, Central Park Zoo, and New York Aquarium. Volunteers give guided tours to school classes and other groups after completing an eight-week training course given at the Bronx Zoo or New York Aquarium. Classes meet once a week, and Saturday classes at the zoo are available.

Interested in becoming a volunteer? If you want to discover what's new at the zoos, contact the Bronx Zoo's Volunteer Services Office at 933-1500, extension 78. If you prefer to get your feet wet, call the New York Aquarium at 266-8500, extension 40.

NYZS ANNUAL MEETING HELD AT PHILHARMONIC HALL

At the seventy-sixth annual meeting of the New York Zoological Society January 26 at Philharmonic Hall, volunteers and instructors from the education department of the Bronx Zoo and New York Aquarium displayed snakes, sparrowhawks, ferrets, and other animals to the more than 4,000 members of the society who attended the event.

Other wild animals, ranging from a young mountain lion to the denizens of a Pacific coral reef, were housed in exhibits keyed to the meeting's theme, "Vanishing Faces." The hit of the animal hospital exhibit from the Bronx Zoo was a baby mandrill baboon which alternately slept and played with its blanket in the isolette that protected it from the cold germs of the many human on-lookers.

An exhibit from the Osborn Laboratories of Marine Sciences depicted research on pollution and microorganisms in the food chain. Viewers were able to glimpse a world too small to be seen by the human eye alone, as special projectors enlarged a microscopic view of microorganisms in a tank of water.

Robert G. Goelet, president of the society, reported on the organization's activities during the past year, and members viewed three films devoted to the theme of threatened wildlife.

NEW TRUSTEES ELECTED TO BOARD

Frederick A. Melhado, Mrs. Ernesta G. Procope, and Mrs. Samuel M. Symonds were elected to the Board of Trustees of the New York Zoological Society on December 14, 1971.

Frederick A. Melhado, a graduate of St. Bernard's School, Phillips Exeter Academy, and Yale University, served from 1953 to 1956 as a Lieut. in the United States Naval Reserve. A member of the New York Stock Exchange, he is a partner of McConnell, Melhado and a director of the Overseas National Airways and the Pleasant Street Foundation. Mr. Melhado is married and has two children.

Mrs. Ernesta G. Procope is president of the E. G. Bowman Insurance Company. A graduate of the High School of Music and Art, she attended Brooklyn College. Mrs. Procope is a member of the Business Advisory Council of the Urban Development Council for the State of New York, vice-president and board member of the New York Urban League, a member of the Advisory Committee of the New York State Gambling Commission, and a member of the board of the New York Urban Coalition. She is married to John Procope, vice-president and general manager of the New York *Amsterdam News.*

Mrs. Samuel M. Symonds is founder and chairman of the Friends of the Central Park Zoo, a committee of the New York Zoological Society. A graduate of Stanford University, she did graduate work in the Masters Program in Speech Pathology at Columbia University. Mrs. Symonds has served on the Hospitality Committee of the Institute of International Education and is the author of a research paper on water pollution for the Parks Council colloquim. Her husband, Samuel M. Symonds, is a corporate lawyer; they have two children.

On the same date, Robert E. Blum and John Elliott resigned from the Board of Trustees and were elected to the board's Advisory Committee. Mr. Blum had been elected to the Board of Trustees in 1954. Mr. Elliott, elected to the board in 1951, was a member of the Executive Committee from 1951 to 1967 and served as Secretary of the society from 1964 to 1967.

The Board of Trustees also voted an amendment to the society's by-laws to allow for *ex officio* representation on the board by the President of the Borough of the Bronx, Robert Abrams, and the President of the Borough of Brooklyn, Sebastian Leone, in further recognition of the two communities in which the institutions of the New York Zoological Society are located.

AQUARIUM CURATOR APPOINTED

Stephen H. Spotte has been appointed Curator of the New York Aquarium and will assume his new duties on February 15. Born in Wheeling, West Virginia, Mr. Spotte, 30, received a B.S. degree in biological science in 1965 from Marshall University in Huntington, West Virginia. He has worked as a diver in the Virgin Islands, as a research associate with the U.S. Army Corps of Engineers, and has held several positions at the Aquarium of Niagara Falls (New York), including those of curator of exhibits, general curator, and director.

A member of the American Society of Ichthyologists and Herpetologists, American Society of Limnology and Oceanography, and Federal Water Pollution Control Administration, Mr. Spotte is the author of *Fish and Invertebrate Culture* and a contributing author to a forthcoming book, *Experimental Marine Biology*. His articles have appeared in such publications as *Sports Illustrated, Underwater Naturalist,* and *Zoo.* Mr. Spotte is married and has two children.

THE bookshelf

AQUARIUM FISHES, THEIR BEAUTY, HISTORY, AND CARE. *Photographs by Douglas Faulkner. Text by James W. Atz. 112 pages. Viking Press, New York, 1971. $10.95.*

Anyone who has ever been interested in tropical fish should read this book. The photographs include many superb examples of Douglas Faulkner's art, and the text is of even greater value. Ostensibly for the beginner, it contains information that will be new to most hobbyists. Following a brief history of fish culture, simple directions are given for setting up a tank. But most important, the directions state not just what should be done, but also why. The reader may be surprised, for example, to learn that water is not pushed up the air lift into the filter by the rising bubbles, and that the main function of the filter is to provide a suitable environment for a large population of nitrifying bacteria. Of particular interest is the point of view that an aquarium is not a bit of nature transplanted indoors, but an artificial, man-made environment whose most extraordinary feature is that it can support fish life at all.

Robert A. Brown

THE LAST OF THE RULING REPTILES. ALLIGATORS, CROCODILES, AND THEIR KIN. *By W. T. Neill. 486 pp., 162 figures. Columbia University Press, New York, 1971. $15.95.*

This book brings together and clarifies much of the story of crocodilian biology. The 27 chapters of text are divided into five parts: part one exposes many of the myths and legends that have sprung from folklore and passed into biological literature under the guise of fact; parts two and three summarize the more than 200 million years of crocodilian history and a few aspects of their classification, morphology, and behavior; part four treats the range, habitat, nesting, young, food, growth, longevity, hibernation, social behavior, and enemies of the American alligator, and its attacks on man; and part five briefly outlines the biology of the other living crocodilians.

The author has little patience with legend-mongers and biologists who uncritically accept fantasy as fact relating to crocodile biology. One of the most fascinating aspects of this book is the author's meticulous tracing of the evolutionary passage of erroneous beliefs from the original author-observer through the writings of five or six later authors. However, in his rush to cast out the fallacies from the scientific literature pertaining to crocodilians, the author is sometimes a bit too zealous. For example, Neill is probably correct in stating that alligators do not use their tails as weapons to knock enemies and prey off their feet. However, when a crocodilian swings its head violently to one side to threaten an enemy or to seize prey, it almost of necessity simultaneously swings its tail to the same side. This counteracts the torque acting on the body as a result of accelerating the mass of the head and neck. Similarly a walking man swings each arm to counteract the acceleration of the forward moving opposite leg. Crocodilians and large lizards that have lost the tail through accident cannot offset the effects of their own threatening lunges and consequently are considerably less agile than specimens with complete tails. If early workers were wrong in interpreting the reason for this tail swing, Neill is no less incorrect in implying its absence.

The author also partly missed the truth in stating that female American alligators do not bite off vegetation for constructing their nest. Recent studies of the species in Louisiana clearly show that the females will tear vegatation loose with their mouths for nest construction. Once loose, however, the female scrapes the nest together using the body and feet as reported by the author. And although not all females open their nests to release the hatchlings, some do.

The author has contributed a number of errors to misinformation on crocodilians. He is incorrect, for example, when he says that little is known about the density of alligator populations; that eggs and hatchlings of *Caiman sclerops fuscus* are not known; that there is little reason to postulate the presence of the Jacare caiman far outside the Paraguay river drainage; that no crocodilian has ever been shown to cache prey underwater; that the estuarine crocodile is not likely to come ashore except to nest or to reach other water; and that gharials hardly ever leave the water except to nest.

Few of the bibliographic sources are clearly indicated in the text of the book. This is sure to frustrate many a reader not thoroughly familiar with the literature.

All of these errors and omissions, while numerous, hardly detract from the general accuracy and worth of the book. The description of the natural history of the American alligator is far superior to any previous general publication on the subject, and the treatment of the biology of the other species of crocodilians is competent. The book is highly readable and the many photographs and figures are excellent.

All the crocodilians of the world are declining in number as a result of over-exploitation by the reptile leather industry. As observed by the author, this book may not only be the first to deal with crocodilian biology in general, but if the present rate of killing continues, it may also be the last. Neill correctly states that the decline cannot be stopped by more laws against hunting —— the poachers are many and the profit potential is high —— but the animals might be saved if laws could be passed against the sale or purchase of crocodilian products. Such laws have been passed in a number of states and municipalities in this country since Neill wrote the manuscript of the book. This book should interest even more people in the present plight of this last group of large reptile carnivores.

F. Wayne King

ABOUT THE AUTHORS

Dr. Emil P. Dolensek is the staff veterinarian for the Bronx Zoo and the New York Aquarium. **Anthony D. Marshall**, a trustee of the New York Zoological Society, is the former United States Ambassador to the Malagasy Republic and has recently been appointed U.S. Ambassador to Trinidad. Science writer **James Powell** is a member of the survival service commission of crocodilian specialists for the International Union for the Conservation of Nature and Natural Resources. **George B. Schaller** is a research zoologist with the New York Zoological Society's new Center of Field Biology and Conservation.

ILLUSTRATION CREDITS

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Design by Peter Oldenburg.

dying species...

"The beauty and genius of a work of art may be reconceived though its first material expression be destroyed; a vanished harmony may yet again inspire the composer; but when the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can be again."

William Beebe
First curator of birds, Bronx Zoo

Photo: J. J. Williams

HAWAIIAN MONK SEAL
Monachus schauinslandi

Many mammals, including wallabies, rats, dogs, mongooses, cats, pigs, deer, cattle, antelope, goats, and sheep, have been introduced to the Hawaiian Islands. However, the native mammal fauna is limited to a subspecies of the hoary bat that arrived by flying and a species of monk seal that arrived by swimming. This seal is the only mammal indigenous solely to the islands of the Hawaiian chain.

About seven feet long, dark brown on the upper surface with paler brown sides and a whitish belly, the Hawaiian monk seal is a member of a unique genus of seals restricted to the warm waters of tropical areas. The other two members of the genus *Monachus,* one from the Mediterranean Sea and the other from the Caribbean Sea, are also called monk seals. All three species are rare.

Found on the small, low, uninhabited islands and atolls that make up "The Leeward Chain" of the Hawaiian Archipelago, monk seals are rarely sighted near the larger, populated land areas. This fact makes it somewhat easier to understand why they were unknown to naturalists until the early part of the present century. It is evident, however, that they were known to seal hunters long before this. In the New York Zoological Society *Bulletin* for November 1913, W.A. Bryan (of Honolulu) reported: "At different times, but especially in 1859, sealing expeditions were made . . . . In that year the "Gambia" returned to Honolulu with 1,500 skins and 240 barrels of seal oil. This furnishes us with a record as to the former abundance of the seal."

The earliest mention of the Hawaiian monk seal was in the log of the brig "Aiona," which recorded the taking of seals for their oils and pelts in 1824. Many thousands were slaughtered before the population dwindled to numbers that made commercial seal hunting an unprofitable business in the Hawaiian Islands. By 1905, the year that it was finally described scientifically, the monk seal was already on the brink of extinction.

Living near land and never having to migrate or wander far into the ocean in search of food, this seal leads a sluggish existence. Groups of monk seals spend their days basking on the beaches and their nights lazily hunting for reef fishes and mollusks in the shallow water around the islands they inhabit.

The monk seal must be grouped with the other animals and plants that make up the island life of Hawaii. The fragility and vulnerability of island flora and fauna is well known. Special adaptations to the conditions of an isolated habitat are common characteristics of all forms of insular life. Sudden changes in an environment allow few options for any species in a small, delicately balanced habitat. The tragic history of the bird life endemic to the Hawaiian Islands is a case in point. Destruction of habitat for land development and the introduction of exotic birds and mammals resulted in the complete disappearance of 26 species of birds during the last century. By the beginning of the twentieth century, the extent of the damage was realized, and President Theodore Roosevelt set aside the archipelago as the Hawaiian Islands National Refuge in an effort to save the birds remaining in that area. No real thought was given to the protection of the monk seal, however, because it was believed to be extinct or already beyond preservation. Fortunately when an area is declared a refuge for one species or group, it protects most of the fauna and flora within it. In this case, the monk seal was among those to benefit.

Total protection, in the form of isolation from human encroachment, has allowed this species to gradually rise from near extinction to a still-increasing population of well over 1,000 seals today. It is unfortunate that the future does not look as hopeful for the Caribbean and Mediterranean monk seals. The Caribbean seal may already be extinct. The remnants of these two species must be preserved as the Hawaiian seal has been, if for no other reason than to remind us of the fragility of our environment and that we have no right to destroy it or its inhabitants.

JAMES G. DOHERTY

Animal Kingdom

August 1972

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Anemonefish Defies its Host

Animal Kingdom

MAGAZINE OF THE NEW YORK ZOOLOGICAL SOCIETY

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Anemones and Damselfishes — Strange Bedfellows

by Stephen Spotte

The puzzling relationship between the sea anemone and some damselfishes is now close to being resolved. How do the small anemonefishes escape being attacked by the carnivorous anemones? New research with radioactive tracers indicate that the host anemone itself provides protective cover for its guest.

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Wildlife of the Wetlands

by Edward R. Ricciuti

The coastal wetlands of Louisiana cover more than four million acres — one of the richest wildlife havens in the nation. It harbors some 300 species of birds, a variety of small mammals, plus deer and alligators. Refuges have been established to protect these wild residents of the wetlands.

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Fairy Penguins on Parade

by U. Erich Friese

The march of the fairy penguins to their breeding grounds on Australian beaches is a sight to behold. These glossy blue-green and black birds are the smallest of the many species of penguins found in the southern hemisphere.

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Faces at the Zoo

Photography by Paul Kovac

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The Making of the Giant Panda

by Joseph A. Davis

A giant panda is what it eats — perhaps. Its exclusive diet of bamboo suggests it is a member of the bear family. But the giant panda also resembles an overgrown raccoon. Called by either name, it may well be eating itself out of existence.

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Biblical Animals in the Holy Land

by Martin Zucker

Animals that once roamed the Promised Land are now finding refuge in a new Israeli preserve. The Haibar refuge is a natural habitat for addax, oryx, ibex, onager, and other species near extinction. Plans are to stock the rare Arabian oryx.

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Vanishing Species *Inside Back Cover*

About the cover

The damselfish comfortably ensconced within the anemone's tentacles has gained protection from its host's lethal stings. Each "petal" of the flower-like anemone is in fact a tentacle lined with numerous poisonous cells that will sting any small fish or crab unlucky enough to brush by them. The tentacles then sweep the stunned animal into the anemone's central mouth. When feeding, the anemone blossoms as it spreads its tentacles; if disturbed, it withdraws them into its tubular body. *Photo by Douglas Faulkner*

Back cover: A young brown pelican strkes a characteristic pose on an old piling on the Florida coast. With its eggs weakened by pesticides, the species is now in danger. (See Vanishing Species, inside back cover.) *Photo by Stephen Spotte*

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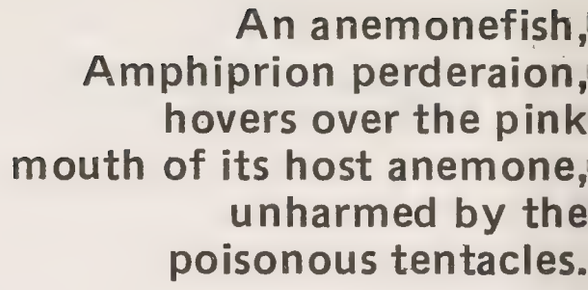
Anemones and Damselfishes Strange Bedfellows



An anemonefish, Amphiprion perderaion, hovers over the pink mouth of its host anemone, unharmed by the poisonous tentacles.

by Stephen Spotte

New research shows how the anemonefish survives in its host's lethal tentacles

Of all the relationships in the sea, one of the strangest is the bond between some small damselfishes and the anemone. The flowerlike anemone seems deceptively harmless, but is in fact a highly efficient carnivore that kills and eats small fishes within its reach. Several fishes of the damselfish family Pomacentridae from the Indo-Pacific region have been observed living comfortably within the anemone's tentacles, but it is the genus *Amphiprion* which has earned the name "anemonefish."

The sea anemone's attack is triggered by the touch of its softly waving tentacles – an aggressive reflex that seems to preclude an amicable association with another animal. Located in each tentacle are numerous tiny, poison-laden capsules called *nematocysts.* When a small fish blunders into the tentacles, the nematocysts instantly discharge hollow barbs into its body and inject the poison. The combined effect of hundreds of discharged nematocysts is to paralyze the victim before it is drawn into the anemone's mouth. The anemonefish somehow avoids such a fate and survives unharmed among the tentacles.

An English naturalist; C. Collingwood, first observed the anemone/anemonefish relationship while he was on a trip to the South China Sea in 1868. Since then, many have speculated on why and how this peculiar bond exists. But not until the recent studies of Richard N. Mariscal of Florida State University and D. Schlichter in Germany has any light been thrown on the true nature of the association.

Who benefits?

When two different kinds of animals are found living together, the association is termed *symbiosis.* If the association is beneficial to one of the animals, it can be further classed as *commensualism;* if beneficial to both, *mutualism.* The anemone/anemonefish partnership is most likely a case of mutualism.

From the damselfish's point of view, the major benefit gained is protection against predators. Christopher W. Coates, writing in *Animal Kingdom* in 1964, noted that anemonefishes at the New York Aquarium induced their host anemones to move higher up the walls of the tank after voracious lionfish had been introduced. Anemonefishes have often been seen eating food discharged by their hosts. A third benefit may be the removal of parasites from the skin of the fish by its associate anemone. This was first suggested a hundred years ago but has yet to be substantiated.

Possible benefits to the anemone are a bit more tenuous. In 1893, it was postulated that anemonefishes acted as lures to draw other fishes into the deadly tentacles, but such behavior has never been seen. In fact, Mariscal thinks the opposite would be more likely: the fish's bright colors may serve to warn potential prey of the anemone's presence.

The anemone would seem to be more dependent upon this relationship than its damselfish partner. Aquarists have often observed the slow demise of an anemone after its fish has been removed. For years people thought that the fish in some way "treats" or conditions the anemone and helps to keep it alive and well. But this is unlikely, since anemones and even anemonefishes are often observed living in nature without one another.

Many researchers and aquarists alike have reported anemonefishes "feeding" their hosts. One time during a routine feeding of the exhibits at the Aquarium of Niagara Falls, I was startled to see a large anemonefish, *Amphiprion xanthurus,* take a

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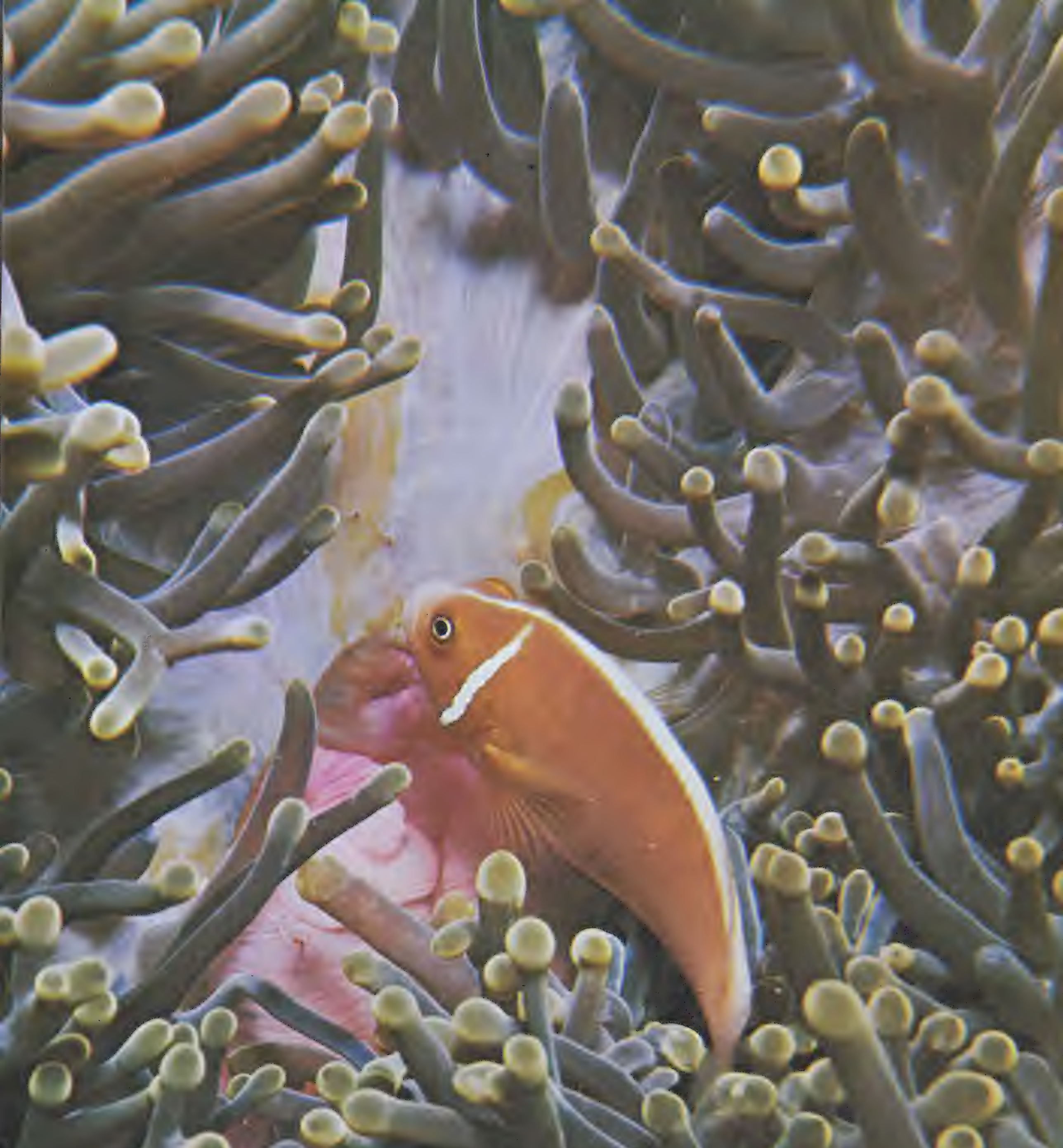
Stephen Spotte, Curator of the New York Aquarium, is an ichthyologist and an avid scuba diver. He has written several books and magazine articles on fish culture and marine biology.

Photo by Douglas Faulkner



piece of food about midwater, swim to the bottom, and deposit it right in the center of its anemone. Others in the tank were doing the same. It would have been easy at that point to read some ill-deserved intelligence into what I was seeing. But just then something else happened to put this behavior back in perspective. In a far corner a smaller fish, without an anemone of its own, was depositing pieces of food underneath a ledge of coral. The apparent "feeding," it turned out, was simply a manifestation of the fish's instinct to bring food to its territory. In one case, the territory included an outcropping of coral; in the other, an anemone.

It would seem that while an anemone may benefit from an occasional "feeding," it can certainly survive without it. The overall relationship appears to favor the fish, with the anemone being an occasional beneficiary.

Getting acquainted

The bond between an anemonefish and its anemone is not innate in the purest sense; it is acquired. Before the partnership is sealed, the fish and the anemone go through a "getting acquainted" ritual called *acclimation.*

When a new anemone and an anemonefish which has been kept isolated from anemones for a time are put together in an aquarium, there is no initial contact. The anemone soon expands and attaches itself to the bottom with its basal disc, but the fish remains at the opposite end of the tank. After awhile, it cautiously approaches the anemone. It may nibble at the tip of a tentacle, or brush lightly against one of the outermost tentacles. After touching the anemone, the fish instantly jumps away, often with a portion of a tentacle still clinging to its body. It then circles the anemone and inches forward again, like a reluctant swimmer about to test the water.

The tempo of the ritual increases. The anemonefish bobs up and down before the anemone, occasionally touching or brushing against it with its chest and pelvic fins before jumping out of reach. The number of individual contacts increases. At the same time, the tendency of the anemone to cling to the fish decreases and its overall behavior becomes acquiescent. The fish, it is plain to see, is no longer stung so intensely.

The fish now stays enveloped in the deadly tentacles for increasingly longer periods, and the number of its ritual contacts diminishes accordingly. At last it relents to the anemone's passive embrace. Acclimation is complete. In most cases, it has taken no more than an hour.

Acclimation time depends largely on the anemone/anemonefish combination. Mariscal tested acclimation times of the anemonefish *Amphiprion xanthurus* to three species of anemones: one from the Philippines *(Stoichactis kenti),* and two from the coast of California *(Anthopleura xanthogrammica* and *A. elegantissima).* The study

Anemonefishes "get acquainted" with their host by brushing against the tentacles or nibbling on them.

NYZS photo by Sam Dunton

was made more interesting because no anemonefishes are native to California and no *Anthopleura* anemones are found in the Philippines. The association, therefore, could never have taken place under natural conditions.

The test fish became acclimated to the Philippine anemone in about 10 minutes. This species of anemone is commonly associated with this particular fish in the wild. With one of the California anemones, *Anthopleura xanthogrammica,* acclimation time was nearly an hour; with the other, *A. elegantissima,* only one in three fish could acclimate at all, and then it took 45 hours.

The question of preference for one species of anemone is far from answered. It is likely that at least one type of damselfish *(Premnas biaculeatus)* may live in association with a single species of anemone. Another anemonefish *(Amphiprion xanthurus),* as just shown, can acclimate to several different anemones, even some not found in its native waters. Still other *Amphiprion* species are killed by certain kinds of anemones and purposely avoid them.

Protective mechanisms

All this leads to the inevitable problem of how it all works. Mariscal has clearly defined the possibilities: either the protective mechanism originated with the anemone, or with the fish. He reasoned that if only acclimated fishes were not stung by the anemones, it indicated a change originating with the fish. If, on the other hand, anemones containing only acclimated fishes failed to sting other fishes (either acclimated or unacclimated), it showed a change occurring with the anemone. As it happened, the first possibility was the right one, and acclimated fishes were not stung by the anemones containing either acclimated or unacclimated fishes.

Evidence that the change originates with the fish was shown by M. Blosch in 1961. Acclimated anemonefishes living among the tentacles of their anemones were killed when the tentacles came in contact with an unacclimated organism, which unleashed the poison capsules. It appears, in other words, as though the acclimated anemonefish survives because it does not trigger the anemone's sting reflex – but the fish is not actually immune to the sting. In a similar situation, *Nomeus,* a small fish often found swimming among the tentacles of the potent Portuguese man-o'-war, cannot survive a massive sting. *Nomeus* eats small quantities of its host's tentacles, thereby building up a partial immunity which protects it in case of an occasional sting. The same may be true of anemonefishes, and could explain why they sometimes nibble at the tentacles of their hosts.

Anemonefish secrete a mucus that is thought to be involved in preventing the anemone's stinging discharge. In 1969 Mariscal reported an experiment in which the protective mucus was wiped from an acclimated anemonefish with a piece of absorbent tissue. The fish was instantly deacclimated. More remarkable, the fish knew it and did not dive back into the tentacles of its anemone until after the acclimation ritual had been repeated.

The protective role of the mucus was shown when Mariscal offered the tropical anemone, *Radianthus ritteri,* pieces of skin and flesh from freshly killed companion fish *(Amphiprion akallopisos).* Pieces of skin and flesh from a grouper were used as controls. When the pieces of each fish were presented skin-side to the tentacles, the anemones immediately stung the grouper skin but not that of the anemonefish. When the pieces were turned over (flesh-side to the tentacles), both were stung and eaten by the anemone.

To confirm that the protection was physiological and not behavioral, Mariscal offered the anemones the freshly-killed whole fish with which they had been living. A deadfish, of course, exhibits no behavior which could inhibit the discharge of nematocysts. In just one case was a dead anemonefish stung, and then only slightly. Accordingly, there is now little doubt that the protective mechanism originates with the skin of the fish.

The German researcher D. Schlichter this year has confirmed Mariscal's findings that the change takes place with the fish. The research was based on the fact that anemones routinely produce substances which prevent nematocyst discharge by mere physical contact. This prevents them from stinging themselves or nearby objects. To reveal the process, labeled tracer chemicals were used – radioactive amino acids that were adsorbed on the tentacles of test anemones. It was found that fishes acclimated to these anemones contained four times more tracer than unacclimated fish. Most of the tracer material was located in those areas of the fishes most frequently in contact with the tentacles. Apparently, the anemonefish uses the anemone's own sting-defeating substance to protect itself. By coating themselves gradually with this substance, anemonefishes are able to live in perfect safety within their host's lethal tentacles.

WILDLIFE OF THE WETLANDS

by Edward R. Ricciuti

Photo by Edward R. Ricc

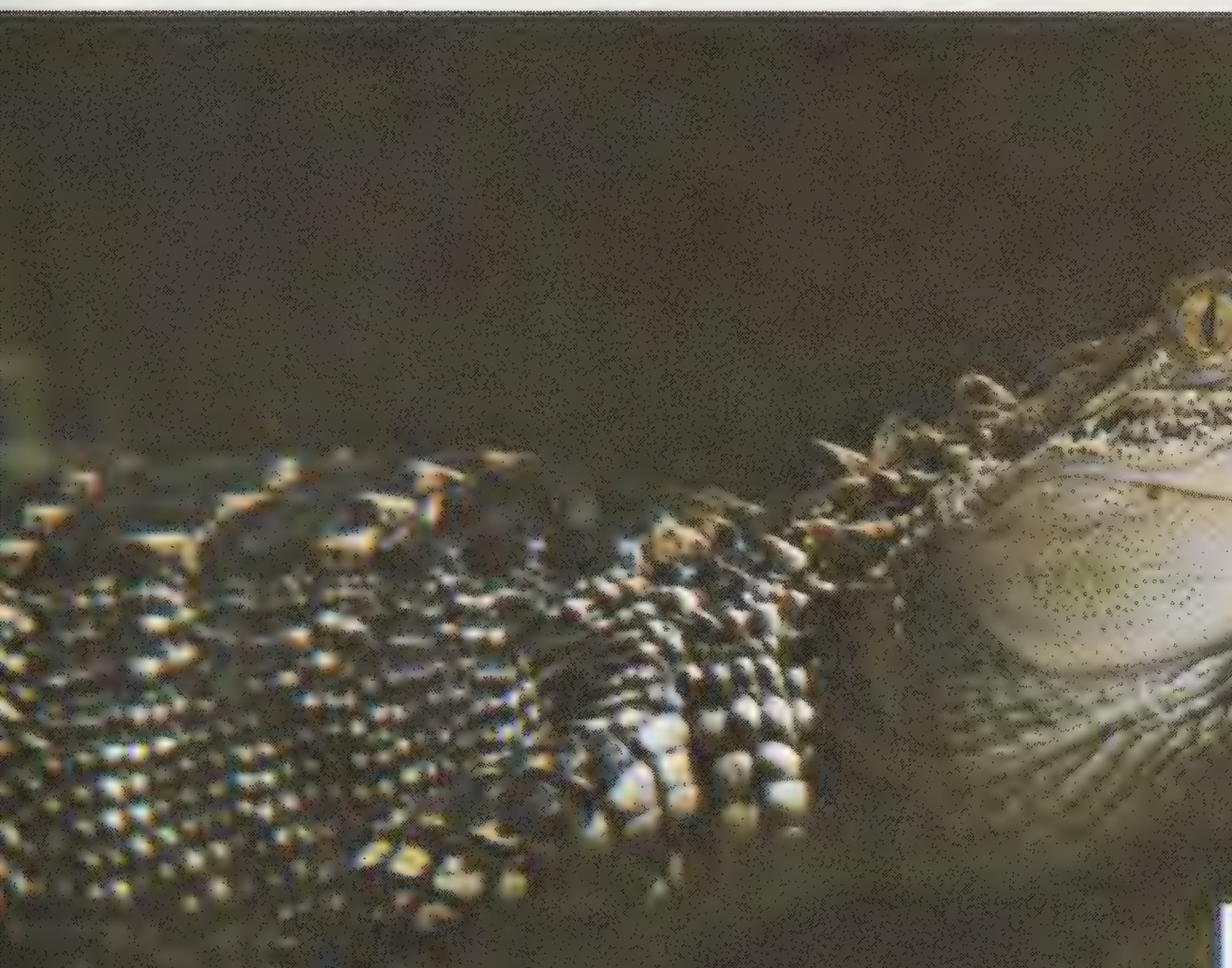
Hurricanes and hunting are the major threats to the teeming wildlife of the Louisiana marshes

I felt like a pauper suddenly presented with the contents of the nation's treasury. Below, extending southward to where the Gulf of Mexico appeared as a thin ribbon of silver on the horizon, stretched unbroken marshland, possessed of those immense natural riches so unique to coastal wetlands. Flying over the vast coastal marshes of Louisiana, I became convinced that to appreciate them fully, one must have the perspective gained from living, as I have, in a state that is bereft of almost all coastal wetlands.

By way of example, Connecticut, my home, has remaining only about 20-square miles of viable coastal wetlands. The coastal marshes of Louisiana, which constitute the state's entire shoreline from Mississippi to Texas, cover more than four million acres. From the copilot's seat in a low-flying aircraft, the vast stands of green marsh vegetation and the myriad muddy-blue lakes and ponds of these great wetlands appear as an uneven patchwork laced with the brown threads of bayous and canals.

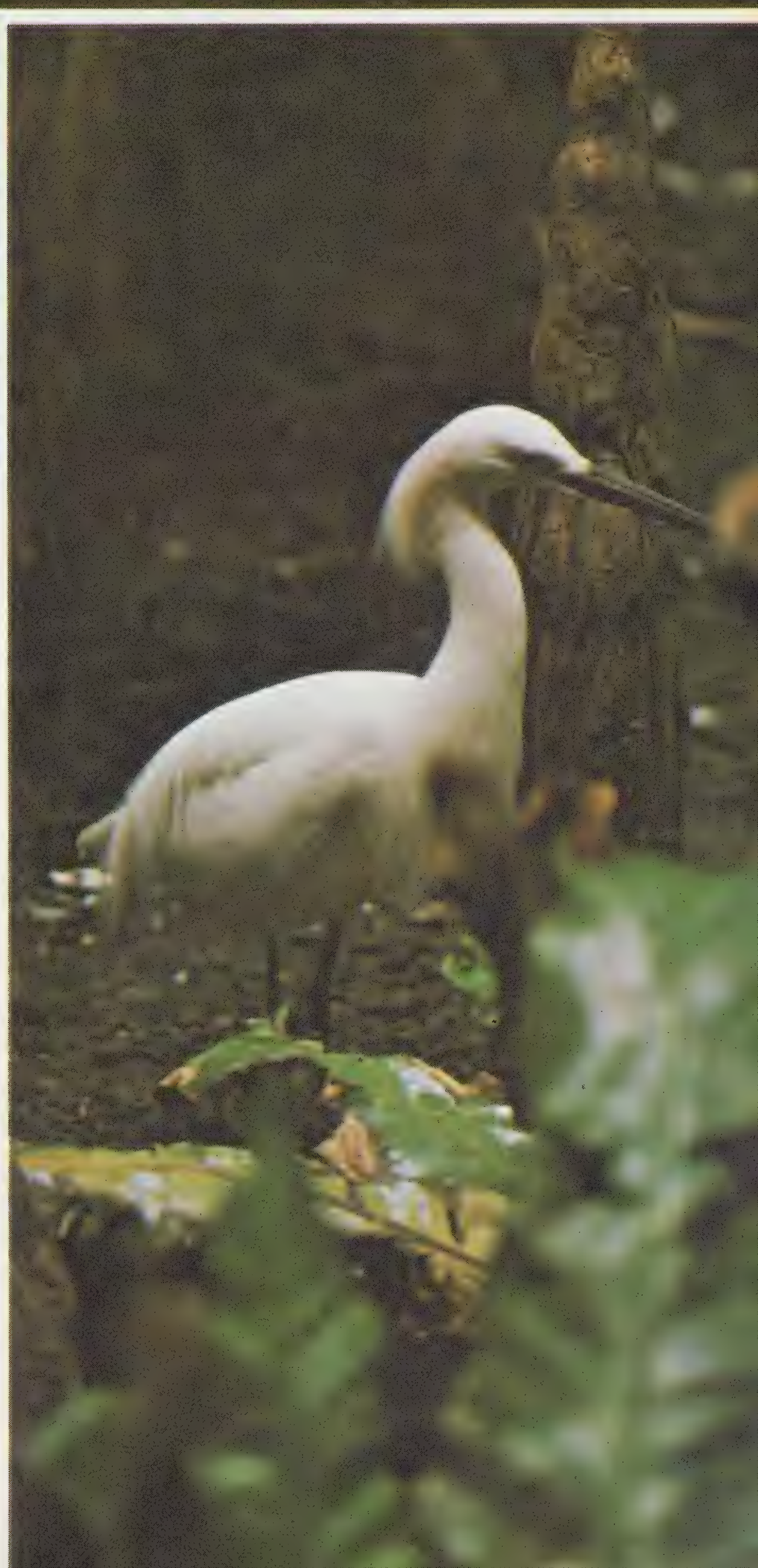
Next to me the pilot of our single-engine aircraft eased it into a banking manuever so that I

Edward R. Ricciuti is the author of several animal books for young people and numerous magazine articles. He was formerly Editor and Curator of Publications of the New York Zoological Society.



NYZS photo by Bill Meng

An estimated 170,000 American alligators live in the coastal marshes of Louisiana. However, while the author saw many specimens within refuge boundaries, none were seen outside the protected areas.



Among the wading birds to be found silently stalking the shallow waters of Louisiana's coastal marshes is the common egret. The American form of this world-wide species is a large, but slender-bodied, white bird, long of leg and neck and beak.

NYZS photo by Bill Meng

NYZS photo

The black mask of the raccoon marks one of the best known American animals, commonly found in the marshlands.

Coastal marshes, covering more than four-million acres, form Louisiana's entire shoreline from Mississippi to Texas.

could see the flock of a hundred or so egrets, each bird gleaming white, that the airplane's passing had stirred up from a black mudflat. From the seat behind me, Dr. F. Wayne King of the New York Zoological Society counted the large alligators that basked on the banks of a large canal.

Refuge for alligators

Dr. King and I had come to coastal Louisiana for a meeting of the American Alligator Council, an organization whose name sometimes draws guffaws from the uninitiated – "A council for alligators?" – but which has inspired much in the way of the legal protection now afforded the American alligator. Curator of Herpetology for the New York Zoological Society, Dr. King was one of the

B.Bruning

founders of the council. After the meeting, held May 4 in Lake Charles, we participated in field trips to two refuges in the marshlands of the State's southwestern corner – the Sabine National Wildlife Refuge and the Rockefeller Wildlife Refuge, the latter operated by the state under a 1920 covenant with the Rockefeller Foundation.

To better see the Rockefeller Refuge in a short time, we had taken to the air. In the eastern section of the coast, the band of marshes extends inland more than 50 miles in some places, forming a near-trackless wilderness best traversed by small boat. The marshes, which as one heads inland grade from salt to brackish to fresh water, are among the most productive wildlife areas in the nation. They provide habitats for many forms of wildlife, particularly aquatic birds and among these especially waterfowl, by virtue of the position of these great wetlands at the southern end of the Mississippi Flyway. Grasses, rushes, and other aquatic plants that provide food for waterfowl and some small mammals grow thickly in the rich soil of the flat, treeless marshlands, which are divided into three zones.

The divider between the two main zones is Vermilion Bay, a large body of water in the center of the coast. To the east of the bay are the sub-delta marshes, and to the west the chenier plain marshes; the third zone, the marshes of the active Mississippi River Delta, covers a relatively small quarter-million acres amidst the maze of bayous and channels in which the river ends at the Gulf.

Wiregrass, *Spartina patens,* is the dominant vegetation of both the chenier plain marshes and the sub-delta marshes. The latter also produce large stands of oyster grass, *Spartina alterniflora,* which takes to regions of higher salinity than its relative, thus testifying that the sub-delta marshes contain more salt marshes than those of the chenier plain.

Islands in the marshes

The chenier plain marshes derive their name from the low ridges of sand and shell that rise from them parallel to the sea. These are the cheniers, sometimes only a foot or two in elevation above the surrounding marshes, which themselves are almost at or even below sea level. Long and narrow, the cheniers are the remnants of soils and debris that piled up on ancient beachlines, when the sea level was higher than it is today. Well-drained and fertile, they support large stands of oaks. Havens in the time of hurricanes, which can send huge waves surging over the marshes, the cheniers are the site of most of the human population of the area. Herds of cattle graze on them, and large flocks of cattle egrets, those amazing migrants from the Old World, patrol for insects in the grasses stirred by the cattle.

Both the Sabine Refuge and the Rockefeller Refuge are in the chenier plain marshes. The headquarters buildings of Rockefeller Refuge rise on high pilings from one of the ridges, Grand Chenier. The reason for the pilings is that even the chenier was no refuge when, in 1957, hurricane Audrey sent waves crashing over the refuge, damaging or destroying all buildings. One refuge employee had to tie his wife to a tree to prevent her being swept away. The hurricane took a great toll in human life, and both the refuge's habitat and wildlife suffered greatly.

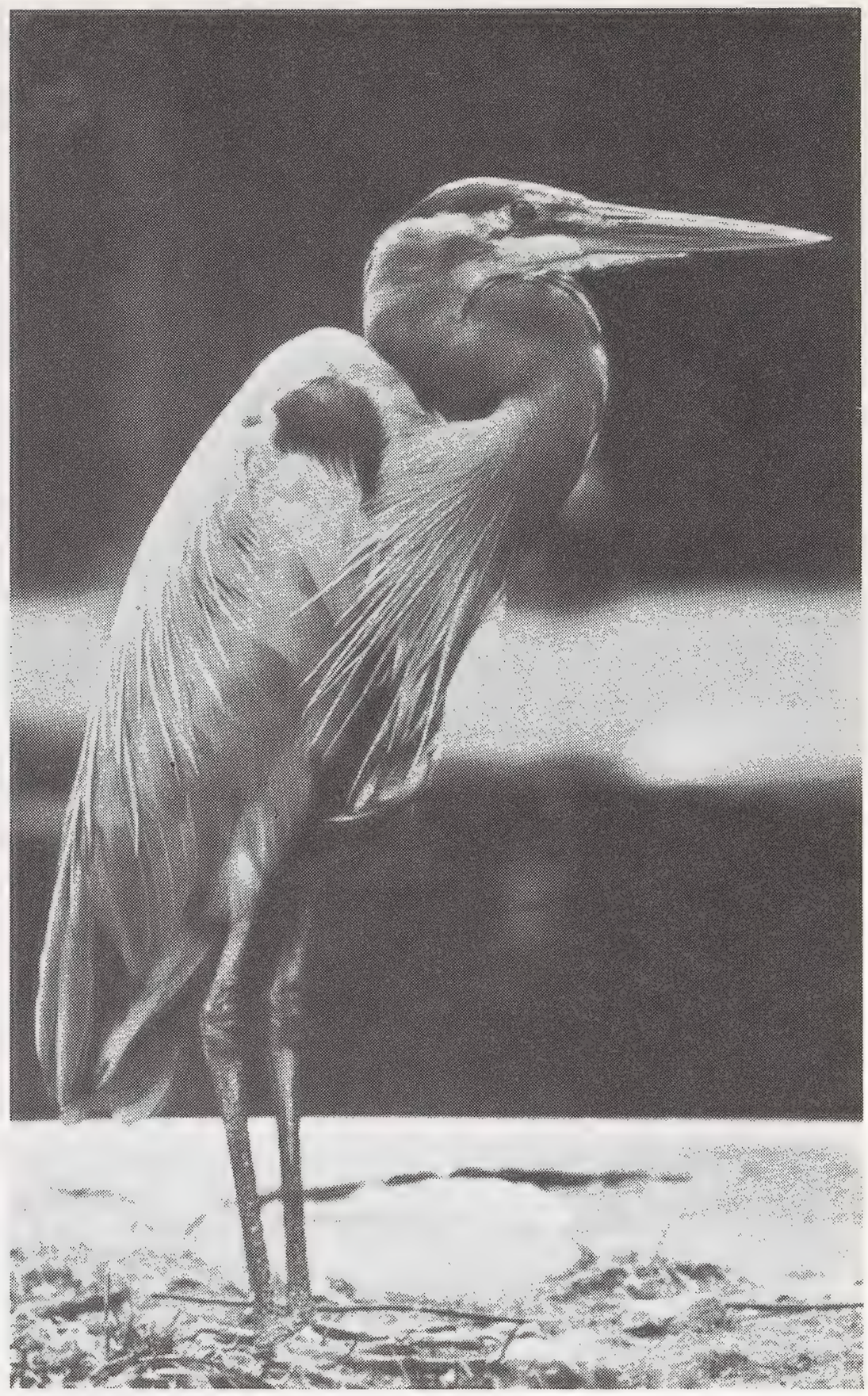
Normally, however, the marshes throb with life. Muskrats and nutria are numerous. Otters search for crayfish or frogs in the marsh waters and raccoons prowl the banks of the bayous. Rice rats scurry about, as do marsh rabbits and cotton rats. These are hunted by the red fox and gray fox, and probably by the rare red wolf, which Federal biologists say still roves the western corner of the marshlands. White-tail deer live in the marshes, especially on the higher ground, and of course, so do the striped skunk and oppossum.

A haven for birds

In the spring, sudden cold fronts may bring waves of migrating warblers, vireos, thrushes and tanagers to the shelter of the cheniers. During our tour of Sabine Refuge, we were greeted by a pair of scarlet tanagers – the male resplendent in his scarlet and black plumage – which flitted among the tall stalks of reed grass *(Phragmites communis).*

Spring also brings flights of assorted plovers, sandpipers, and other shorebirds to the marshes. Some of the shorebirds stay, while others continue to breeding grounds in the north. Red-winged blackbirds and boat-tailed grackles call raucously from among the dark-green stalks of spikerush, which rattle stiffly in the breeze.

Wading birds of many species stalk fish, frogs, and invertebrates in the shallows. Among the wading birds that nest in the Louisiana marshes are common egrets, Louisiana herons, great blue herons, little blue herons, snowy egrets, white ibises, and white-faced ibises. The open water seems alive with grebes and coots, while anhingas and double-



The great blue heron is another wading bird of the marshes. Gray-blue in color, it measures about 52 inches from the tip of its beak to the tip of its tail.

NYZS photo

crested cormorants sun themselves on the limbs of dead trees that rise from the water in some places.

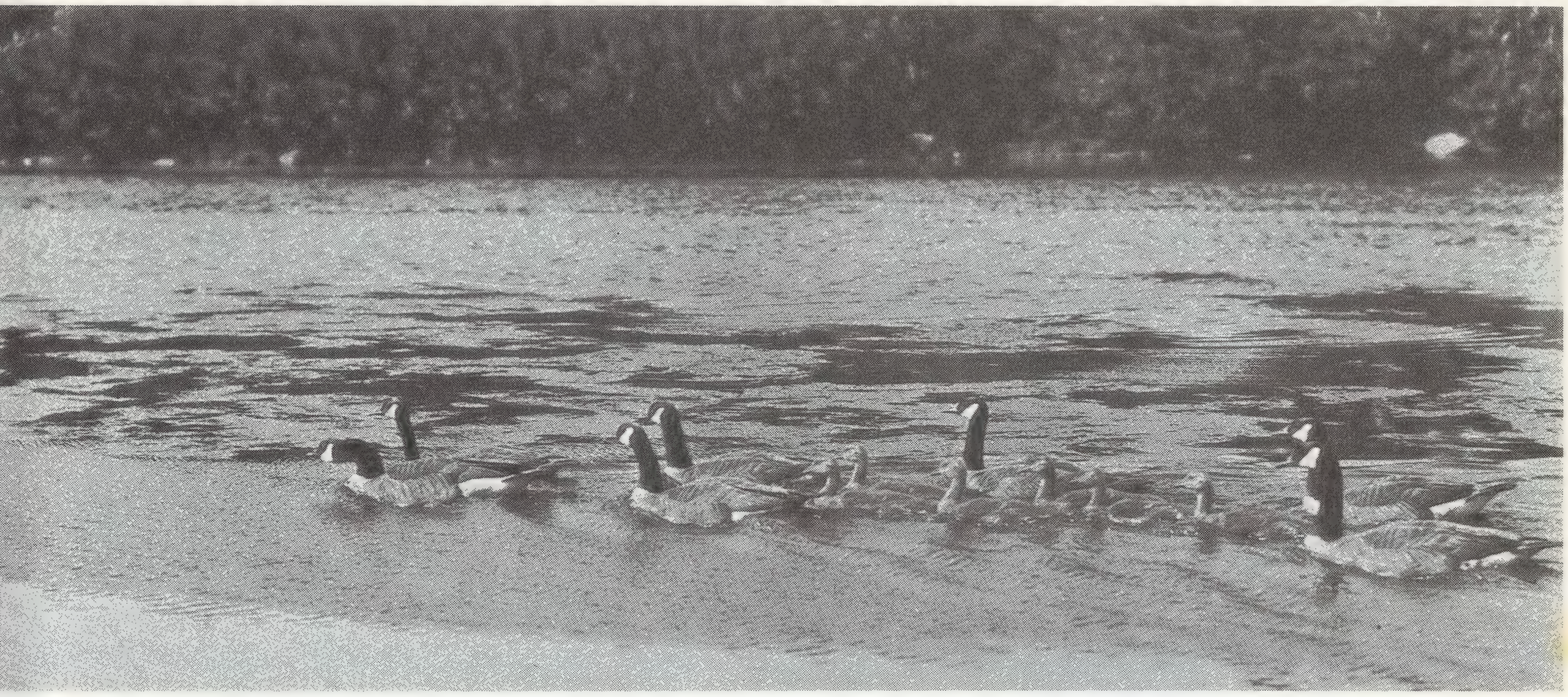
All told, more than 300 species of birds are found in the Louisiana marshlands at one time or another, of which less than a score are seen only rarely. Few waterfowl breed in the marshes but they winter there by the hundreds of thousands. During autumn, flight after flight of ducks wheel overhead and settle amidst the wiregrass. The open water is crowded with shovelors, American widgeon, ruddy ducks, hooded mergansers, pintail, lesser scaup, teal, mallards, black ducks, and others. With them come the snow geese, blue geese, and white-fronted geese, some of which have traveled from as far away as the Arctic.

Wintering ground for waterfowl

Large numbers of Canada geese – sometimes up to 150,000 of the big honkers – used to winter in the Rockefeller Refuge. However, the cultivation of extensive grainfields along the midwestern section of the migratory route of the Canadas has tended to siphon off most of them before they reach the coast. In 1960, in an attempt to restore the Canada goose population of the region, biologists at Rockefeller Refuge pinioned a small number of adults in hopes that the strong ties that bind young geese to their parents would encourage offspring to remain around the refuge. Today the refuge has a flock of 3,000 free-flying Canadas, many of which live in open pens near the headquarters. On the headquarters area, in fact, one is more likely to bump into a Canada goose than into a person.

It is only when their importance as a wintering ground for waterfowl is considered that the Louisiana marshlands assume their true significance as a wildlife haven. Waterfowl that populate a vast portion of North America are dependent on these marshes for several months each year. Any destruction of marsh habitat, therefore, imperils duck and geese populations over a much wider region than the marshes themselves.

NYZS photo



Louisiana state biologists are attempting to restore the large numbers of Canada geese that once wintered in the Rockefeller Refuge.

Much of the Louisiana marshland is included in refuges, but large tracts are privately-owned. Thus far, however, despite extensive petroleum operations, most of the marshland has remained relatively intact, largely as a result of management and conservation of habitat to support wildlife for trapping and hunting. Large tracts of privately-owned land are leased to fur trappers, resulting in substantial income to those who own the land. Some state officials are urging that the state's ban on alligator hunting – such a ban exists in all states where the alligator resides in the wild – be lifted so that alligator-hunting rights similarly could be leased.

The reasoning behind this is that the landowners would preserve the alligator habitat, rather than develop it for other purposes. Many conservationists object, saying that such a course merely would encourage poaching, which has continued in the Southeast despite laws designed to protect the alligator.

State biologists estimate that 170,000 alligators live in Louisiana's coastal marshes. And indeed, alligators, some eight feet and more in length and many three years and four years of age, swim in almost every pool and channel of the Sabine and Rockefeller Refuges. During a 20-minute flight over the Rockefeller Refuge, we saw almost a score of large alligators basking at waterside. Many more were probably hidden by the wiregrass stands and the water of lakes, bayous, and canals. Numerous alligators could be counted in roadside ditches near the Sabine Refuge headquarters – and by only a cursory count from a fast-moving car. However, we traveled many miles of highway near the refuges, but outside their boundaries, and although we scanned the roadside ditches and open water, and surveyed the vast mats of alligator weed and pickerel weed that covered many of the marshes inland of the refuges, nowhere did we find alligators.

Alligators prefer a fresh water, or at the least, a brackish habitat. Normally they shun saline marshes, although when water salinity is low in spring and summer they may venture into the seaside areas. On rare occasions, they even nest in salt marshes. However, the alligator chiefly is a resident of marshes with no or little salinity. Therefore it would seem that alligators should have been as numerous, or even more so, in the freshwater marshes slightly inland of the refuges. As this was not the case, it must at least be suspected that poachers continue to wreak havoc on the alligators of Louisiana's coastal marshes, and that only in refuges where the reptiles are protected – and this protection certainly can be circumvented by the more desperate among the poaching fraternity – do their numbers remain substantial. This possibility, even if it be remote, dictates that one must be wary that opening even a short season on alligators might play into the hands of those who wish to slaughter the reptiles en masse for their hides.

Fairy Penguins on Parade

by U. Erich Friese

Each year thousands of these small penguins march before visitors to their breeding grounds on Australian beaches

As dusk begins to set in over Phillip Island, off the coast of Victoria in southeastern Australia, and the pounding surf rolls on to the sands of Summerland Beach and Cat Bay, a strange and yet familiar bird can be seen emerging from the receding waves. As following waves deposit more of them up on the beach, dozens of these birds, easily recognized as penguins, stand there and wait, like little men in formal dress attire.

When a sizeable group has assembled they begin to march – in the penguin's typical waddling gait – like soldiers in a platoon formation. They parade past hundreds – often thousands – of visitors, who are separated from the birds by simple rope fences. As many as 5,000 people in one night have come to see this unique display of Australia's famous fairy penguin parade.

Habitat of a flightless bird

During the nineteenth century a zoologist once claimed that there was no greater anomaly in nature than a flightless bird. Although for many years we have known better, it is easy to understand Captain James Cook's puzzlement when he first discovered the fairy penguin at Duskey Bay, New Zealand, in 1773. From specimens taken by

U. Erich Friese is Curator of Fishes at the Taronga Zoological Gardens Aquarium in Sydney, Australia. A frequent contributor to ANIMAL KINGDOM, Mr. Friese was formerly Assistant Curator of the New York Aquarium.

Cook's party, *Eudyptula minor,* the fairy penguin, was originally described.

The fairy penguin, also referred to as little penguin or little blue penguin, is considered to be the most primitive penguin species. With a maximum height of only 15 to 16 inches and a weight of perhaps four pounds, it is the smallest of the 17 species of penguins found in the cold and temperate waters of the southern hemisphere. It is also the only penguin that breeds regularly and in large numbers on the Australian mainland. It inhabits the shoreline of the southern half of Australia from Perth and Brisbane, and extends from there south over Tasmania to New Zealand and the Chatham Islands.

Although this attractive little penguin, with its beautiful blue-green gloss over the black back feathers, has suffered considerable reduction in numbers through loss of habitat, it still maintains sizeable breeding colonies along the southern coastline of Australia. It is particularly abundant off Victoria throughout the Bass Strait. But despite its wide distribution, *Eudyptula minor* is not really a migratory bird. Specimens tagged on Phillip Island have been recovered usually within a 50-mile radius, although one bird managed to cover 355 miles in about 30 days.

Ecstatic display

Just like its larger cousins in Antarctica, the fairy penguin has a well-defined social life. A rigid set of special social signals (displays) helps in establishing territories, and they announce the individual's status as a mated or unmated bird and its sex. Displays also figure prominently in the pre-copulation behavior, and in strengthening the pair bond between mated birds. While individual penguins go through so-called "ecstatic" displays, two or more birds are rather frequently involved in "mutual" displays, which are vigorous and quite noisy.

The birds involved stand unnaturally erect and with their flippers outstretched and vibrating. Simultaneously they emit a wailing cry. It starts out as a low note, which is repeated about a dozen times at a progressively higher pitch. It finally ends on a high note, while the birds hold their heads high, with their beaks half open and their throats expanded. At the peak of this mutual display the birds touch each other and slap each other's backs with their vibrating flippers.

Nest in a burrow

The breeding season for the fairy penguin extends from September through March, thus it lasts from the southern spring through the summer and into the fall. The breeding grounds are not very densely populated, but widespread colonies develop because of easier soil penetration in certain areas. Essentially, the fairy penguin likes to build its nest in a burrow, which it has to dig into

Every evening from September to February, fairy penguins march to an acre of grassy hummocks capping the south shore of Phillip Island, Victoria, where they will breed.

Australian News and Information Bureau photo

the ground. However, substitutes are often accepted. Thus it is common to find fairy penguin nests in assorted holes, rock crevasses, and small caves. An occasional nest might even be located under a house, tussocks, and tree stumps or in culverts and storm sewers. Nesting pairs can be found almost anywhere, from sea level, along slopes right up to the top of high cliffs.

The actual nest is usually built out of dried grass and seaweed, small sticks, and other related items (which may include such odd things as ice cream sticks and cigarette butts). Contrary to the New Zealand form of *Eudyptula,* the Australian fairy penguin keeps its nest fairly open. Usually there is a rather small entrance into the nest, through which the bird can barely squeeze. Inside, however, there is sufficient room for the breeding birds to stand up.

The eggs are white, approximately the size of domestic hen eggs in width but less ovoid. The usual clutch size is two eggs. Usually both parent birds alternate sitting on the eggs. However, to what degree female and male share the incubation varies among pairs. It has been reported that in the New Zealand form, the female carries the chief burden of the incubation. The average incubation time seems to be about 35 days for most pairs. During this period, one bird is being relieved during the early hours of the night, and the other shortly before day break.

Parents take turns

For the first 10 to 12 days after hatching the young fairy penguin chicks are covered with short, very thick, soft down. During the first two weeks of their lives the chicks are continuously attended to by their parents. The adults feed the chicks by regurgitation several times during the night. After about two to three weeks, the parents alternate in attending the chicks. This means that one parent may remain inside the nesting burrow for the following day, after having fed the chicks, and not return to the sea again to gather food until the next night. About 50 days after hatching, the young penguins are fully fledged, and a few days later they go to the sea to fend for themselves.

The fairy penguin has the shortest breeding cycle of all penguin species. There appears to be strong evidence that a substantial number of fairy penguins may produce a second clutch of eggs, even after the first has produced offspring. Bird banders in Victoria, Australia, discovered that some breeding pairs were successful with both clutches, while others succeeded with their second clutch after the first one had failed to produce viable chicks. Usually the same burrow was used for the second clutch.

At the end of the breeding season the adult fairy penguins will lose their old plumage. Their old feathers have become frayed from a year's wear and tear, and they are also subject to parasites that feed on keratin, the material which makes up the feathers. Occasional fights among the birds also cause some loss of feathers. Thus, as soon as the young birds have left the nest, the parents will go into their annual molt.

Shortly before the actual molt begins, the birds will increase their food intake dramatically – their weight often increases by almost 50 per cent. Then the birds reenter their burrow, which they will not

A group of fairy penguins are fed by the aquarium keeper at the Taronga Zoo, Sydney, Australia. In the wild they feed on small shrimp, but at the zoo they have adapted to a diet of small frozen fish.

Photo by U. Erich Friese

Photo by U. Erich Friese

The fairy penguin, Eudyptula minor, is the smallest of 17 species of penguins that are found in the southern hemisphere, and has the shortest breeding cycle.

leave until their plumage has been changed — within about 14 days. With their water-repellent properties thus restored, the fairy penguins — after having lost all excess weight again — will return to the sea.

A speedy swimmer

Food studies on the fairy penguin have shown that it feeds mostly on pilchards and krill (a small herbivorous shrimp) in the wild. (Considerable longevity records of this species of penguin at the Taronga Zoo in Sydney have shown the fairy penguin to be very adaptive to other kinds of frozen small fish as food.) The small, but very powerful flippers of this penguin enable it to swim at speeds of up to about 30 mph, with great directional versatility. The fairy penguin can swim circles around a school of small fish. It thus herds the fish into a tight clump from where it selectively picks out its prey.

The natural predators of the little fairy penguin are large birds, such as swamp harriers, peregrine falcons, white-breasted sea eagles, and Pacific seagulls. Tiger snakes, water rats, and even the blue-tongued lizard prey to some extent on the eggs of this penguin. And then, of course, there is man.

Fairy penguins have come ashore on Summerland Beach for centuries. However, many years ago "progress" came to the beach in the form of a new road. At first a few people came to watch the incredible parade of these delightful little birds. Then a bridge was built to Phillip Island and within a short time, uncontrolled thousands of tourists practically trampled the fairy penguins to death. Nestlings were dying by the thousands because their parents failed to reach them and feed them. At the height of the destruction — in 1955 — the Fisheries and Wildlife Department of Victoria set aside areas for the protection of *Eudyptula.* Certain areas were declared off limits to tourists between sunset and sunrise. Although the fairy penguin is now totally protected by law, man still kills many of these birds by much more subtle means. Many are brought each year to the Taronga Zoo in Sydney, with their feathers thoroughly covered with crude oil. Most of the birds brought into the zoo eventually recover, but how many are killed each year by such pollution of the inshore waters? With large-scale oil drilling projects either planned or already in operation along Australia's southeastern coastline, the future of the delightful little fairy penguin is very much in doubt.

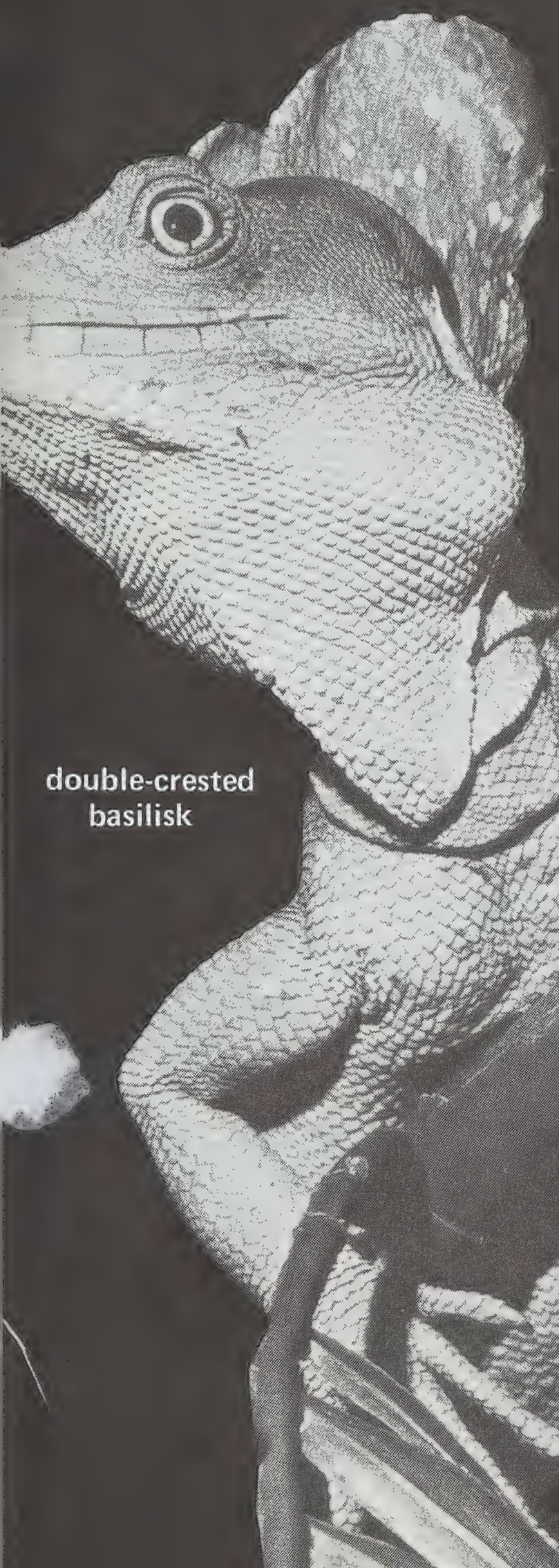
Fac

leopard

es at the Zoo

Photography by Paul G. Kovac

Paul G. Kovac is an amateur photographer who specializes in animal subjects. He is a frequent visitor to the Bronx Zoo, where these photographs were taken. His knowledge of animal behavior combined with fine craftsmanship have resulted in these striking portraits.



double-crested basilisk

kingfisher

ring-tailed lemur

Phillipines monkey-eating eagle

mandrill

Is it a bear or a raccoon? This puzzle of the panda has troubled taxonomists for over a century.

The Making of the Giant Panda

by Joseph A. Davis

The discovery of a spectacular new species of animal occasionally gets off to a stumbling start when only a fragment of the beast comes to light. The okapi, first known only from a bit of skin from its striped leg, was for a time believed to be a new species of zebra. The world's only aquatic marsupial, the yapok, whose skin arrived in Europe without skeletal material, was proclaimed a dwarf otter. Such errors quickly resolve themselves as new specimens are found, and science is none the worse for the experience.

But the giant panda has had other problems. It was launched upon the zoological scene quietly enough as an unusually colored bear. Then, a year later, it was redesignated a cousin of the raccoon. In the century that has followed its first recognition in 1869, it was pushed and tugged back and forth between the raccoon family and the family of the bears, with some attempts to set it up in a new family of its own. And for 32 years it was not even known by its present name, panda.

The "parti-colored" bear

The Chinese hill-country peoples of Szechwan called it a bear – bei-shung, or white-bear – and its European discoverer, the French Jesuit Father Armand David, referred to it as the "parti-colored bear" in the vernacular; it was he who described it taxonomically as a bear, as well.

What difference, really, does it make whether the giant panda is a bear or an overgrown raccoon? To most persons it probably doesn't matter at all, but as one more piece in the jigsaw puzzle that is Nature, it does matter to the zoologist. If the panda is a procyonid (a member of the raccoon family), it is the largest by far, and in many ways quite the most aberrant. It would be the most specialized feeder of the family, most of the other members of which are omnivorous. If it is a bear it is equally aberrant in diet and in many other aspects of its behavior. In short, it really doesn't seem to be a very good member of either family. (All reports indicate that in the wild, the giant panda eats mostly bamboo, whose stalks it grasps with a special thumb-like bone near its wrist. However, recent studies hint that its diet may be less restricted than had been thought.)

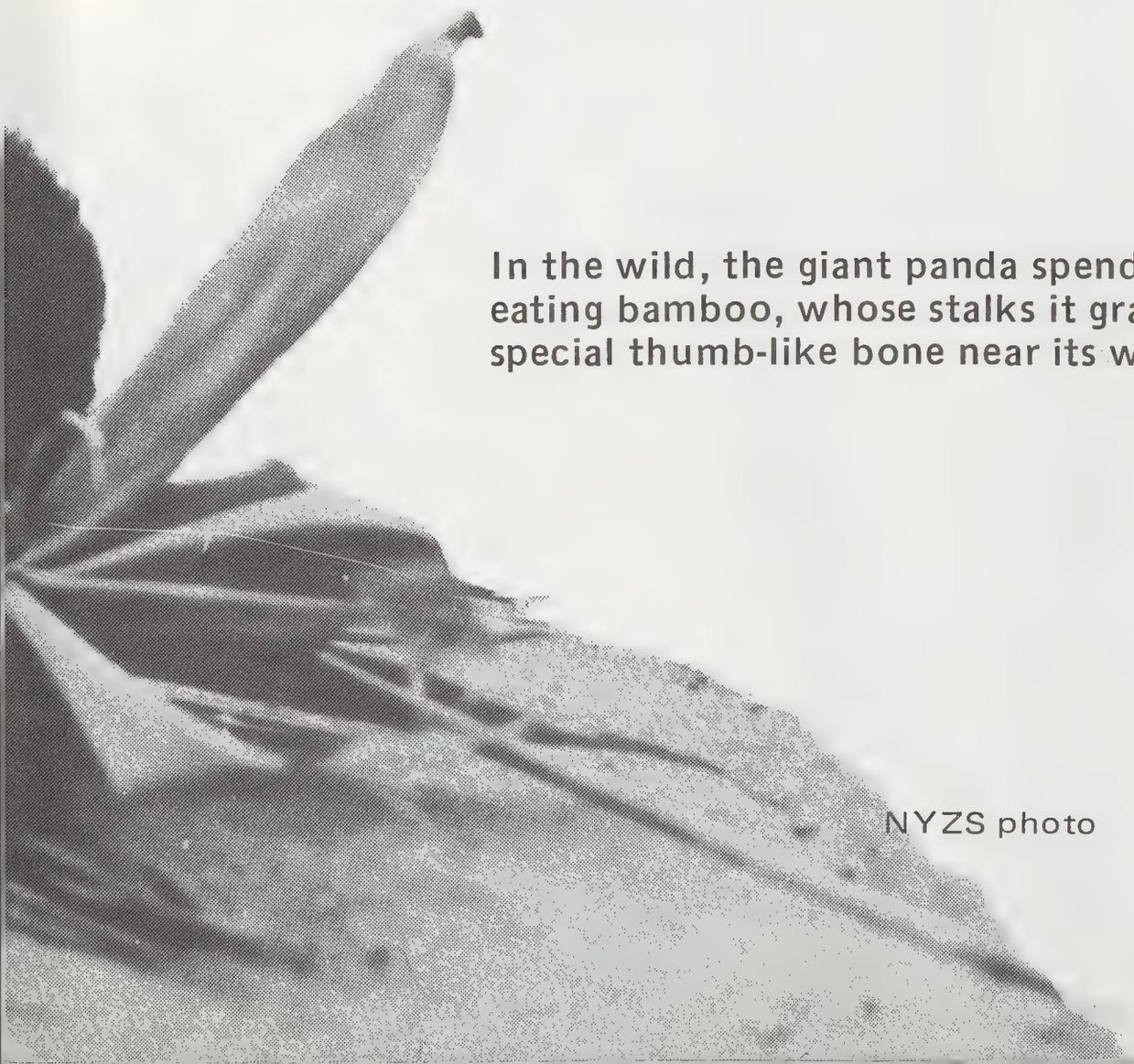
Generally speaking the American and English taxonomists have classified the giant panda as, in effect, an overgrown raccoon, while the continental Europeans have traditionally lumped it with the bears.

Sifting the evidence

What is the evidence? Much that has been published is the result of the old, tried and true taxonomic techniques that have been so useful in providing a true picture of most of the mammalian spectrum. But the panda is, to borrow Winston Churchill's phrase, "a riddle wrapped in a mystery inside an enigma," and one cannot avoid the suspicion that, so far as the panda is concerned, taxonomists have been forced into the unfortunate positions of the blind men examining the elephant.

If you lean to calling the panda a bear, you can cite a lot of evidence, the highlights of which are these: the panda is the size of a bear; its brain looks more like a bear's than a raccoon's (when I say raccoon in this sense, I really mean to include the raccoon's entire family, and use this familiar animal as a symbol of the group); and the panda can stand erect, and often does, as bears do.

Joseph A. Davis is Scientific Assistant to the Director of the Bronx Zoo, and is a mammalogist by training. He is presently writing a book on the giant panda.



In the wild, the giant panda spends much of its time eating bamboo, whose stalks it grasps with a special thumb-like bone near its wrist.

NYZS photo

The panda gives birth to a cub disproportionately small for the mother's size, as bears do – a newborn panda is about 1/800 its mother's weight, while the ratio in the similar-sized black bear of North America is 1:500. (A raccoon cub, part of a litter of several, weighs about 1/20 of what its mother does.) Like bears, the giant panda rakes the bark of trees with its claws, presumably as a territorial sign. The panda's blood proteins are more bear-like than raccoon-like.

On the procyonid, or raccoon, side of the ledger, are these considerations: the panda does not become torpid in winter, but is apparently active all year through; and finally (we have eliminated a number of valid points of similarity for the sake of brevity), the giant panda does sound more like a raccoon, with its bleating call and other sounds. It has not been heard to roar, as a bear can, but it has been said to have a deep growl, and the male, by one hunter, at least, is said to roar in the breeding season.

Tracing the family tree

The attempt to trace the giant panda's genealogy is clouded by two factors. First, the families of the bears and the raccoons are so closely related that the differences between them are not very great to begin with. Second, the panda is so extensively specialized for consuming the low-nutrient bamboo that its anatomy, soft and skeletal, has been greatly modified from its ancestral form. The panda is probably not quick-witted enough to catch meat. Since it digests bamboo poorly, it must stuff itself almost continuously to obtain sufficient nutrition. Not surprisingly, as the bamboo goes, so does the panda, and its habitat may become more restricted in the future.

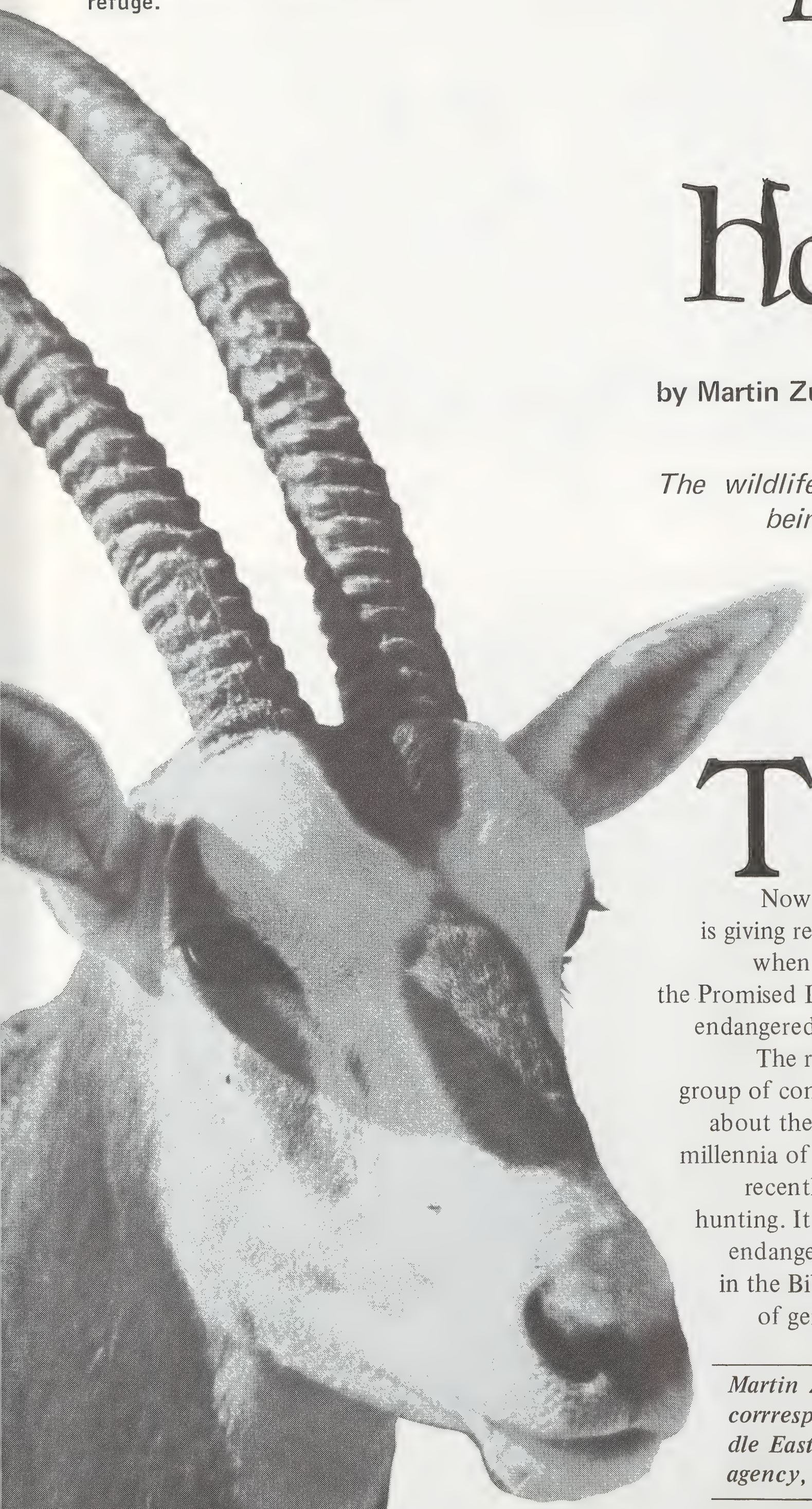
Behavioral studies, when they are made in depth, will do much to clear the air, but for the present it seems as though the most practical view to take is that it really doesn't matter that much zoologically whether the panda is a raccoon closely resembling a bear, or a bear that resembles a raccoon. Whatever the panda's ancestors were, it remains today as a classic example of how far a species can go to narrow its environmental requirements. Why an ancestral species in a group that is as adaptable as both the raccoon and bear families have been should whittle away its options for survival, or have them whittled away, is a mystery. In the process, Nature has produced in the panda a unique and fascinating beast, but one which is already rare because of its self-limiting habits. And one which will long be extinct when the adaptable bears and raccoons are still living with man, or in spite of him.

The giant panda is often pictured as sitting or climbing, but is can also stand erect, as a bear does. It rakes the bark of trees with its claws to stake out its territory.

NYZS photo by Sam Dunton

Biblical Animals of the Holy Land

The graceful scimitar-horned oryx, one of the endangered desert animals in the Haibar refuge.



Photos from Brian Calvert

by Martin Zucker

The wildlife of ancient Palestine is now being restored in an Israeli preserve

The Bible called it a land with brooks of water. Here the ancient Israelites encamped during their 40-year journey from Egypt to Canaan.

Now, 33 centuries later, this same ground is giving refuge to wildlife that roamed the area when the Israelites paused on their way to the Promised Land. Many of those animals are now endangered. Some are extinct.

The refuge, called Haibar, is the work of a group of conservation-minded Israelis, concerned about the destruction of native wildlife during millennia of neglect and armed struggle and most recently through the advent of mechanized hunting. It will be used in an attempt to restore endangered species and creatures mentioned in the Bible, and also to create an animal park of genuine tourist and educational appeal.

Martin Zucker is a former Associated Press corrrespondent who has covered the Middle East. He is now a director of the news agency, Mideast Media.

Two young Nubian ibex rush to lock horns, which will grow into great knobbed crescents.

Its 10,000 acres of savannah-like, semi-arid land, rich with acacia trees, lies in the hot rift valley called the Arava, about 25 miles north of the town of Eilat on the Gulf of Aqaba. The reserve is just north of Timna, the location of King Solomon's copper mines. The Jordanian border, which bisects the Arava from the Dead Sea in the north down to the gulf in the south, is just beyond Haibar's eastern boundary. The area was chosen because of the high water table and the availability of good grazing grasses. Here the animals will be free to roam in a substantial area that fulfills their natural requirements and is free from predators.

The driving force behind Haibar is General Avraham Yoffe, an ex-officer who retired from the Israeli army eight years ago to become the first director of the Israel Nature Reserves Authority (NRA). He is responsible for the development of habitat parks and bird sanctuaries, and for the protection of coral reefs and wild flowers. The Haibar refuge is one of Yoffe's leading projects. He feels an urgency to save the historical wildlife of the region. "Many of these creatures are extinct in Israel and fast disappearing elsewhere," Yoffe says.

But the purchase of rare animals and fencing off thousands of acres has been a slow process because of a small budget. The Israeli government has provided about half of the required funds. Additional contributions have been received from private sources. With the aid of the World Wildlife Fund, some animals were purchased from dealers in the United States and Europe.

According to Yoffe, the plan of the NRA is to purchase more rare animals and build up breeding herds of ideally 15 females and five males. These would form the nucleus of larger herds that would freely roam the area. Yoffe thinks Haibar has enough vegetation to sustain only 120 to 150 animals. He hopes he can create new reserves in the Negev Desert to the west and begin to restore its shrunken wildlife population with animals bred at Haibar.

Building new herds

"This is all slow work," said Yoffe. "We must enlarge carefully and step-by-step, keeping a close watch on growth rates and availability of food. We don't want to go too fast and make a serious mistake that could affect the balance of the animal community."

At the present time, the reserve has an animal population of five addax, 11 onagers, five scimitar-horned oryx, about 25 Nubian ibex, and three dozen dorcas gazelle. All of these animals are

listed as endangered species by the Survival Service Commission of the International Union for Conservation of Nature and Natural Resources.

Yoffe has immediate sights set on the purchase of some rare Arabian oryx and Ethiopian blue-necked ostrich. The latter are the most similar living form to the Syrian ostrich that once roamed the Holy Land. The last ones were seen in the 1920s. No one knows for sure if the addax, a hardy and heavy-legged antelope, is the *dishon* mentioned in the Bible. At any rate, this unique animal, which ranges through the broad belt of the Sahara, found a home in the Haibar reserve.

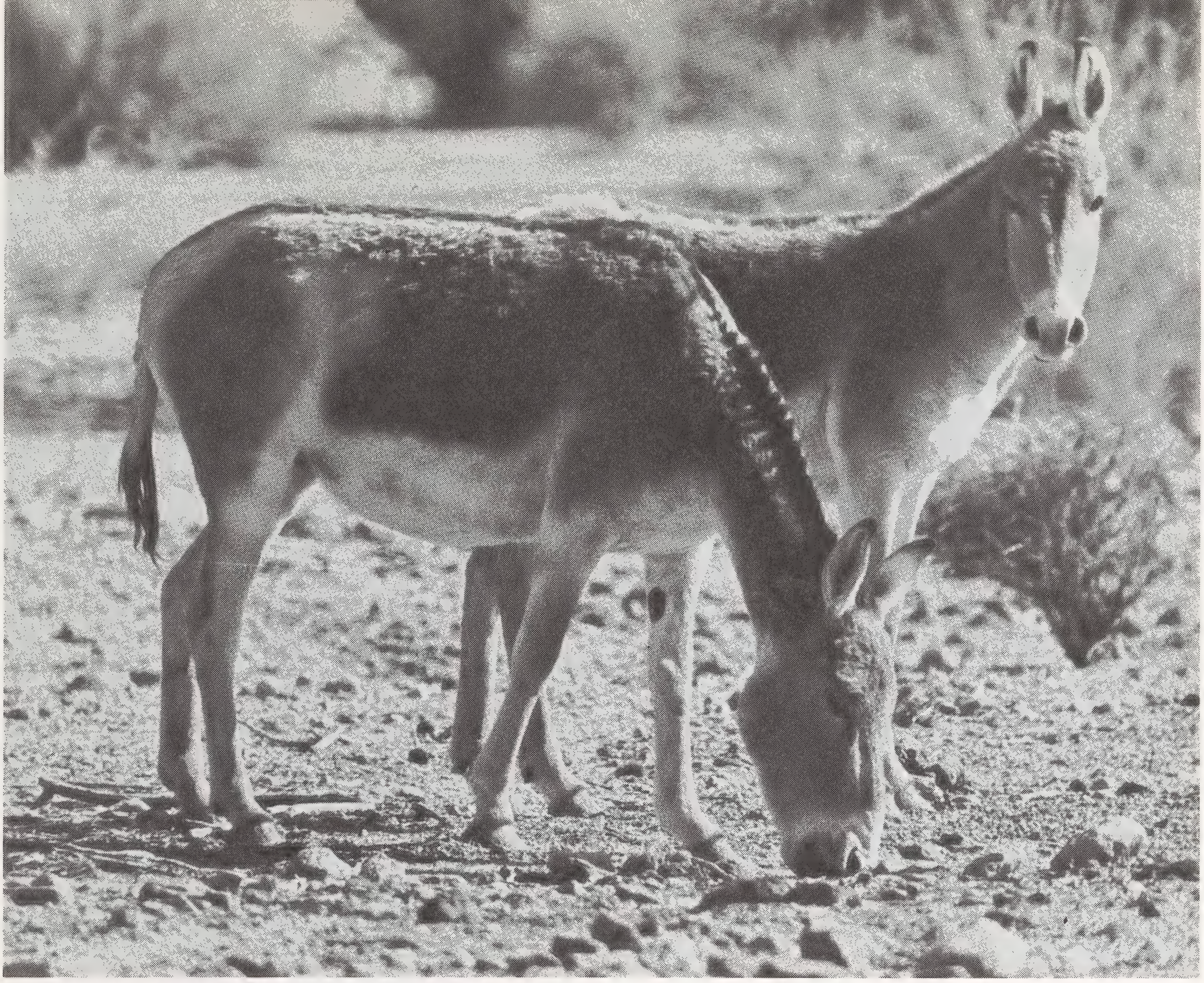
The addax is a true denizen of the desert, having adapted itself to some of the most extreme conditions on earth. It obtains moisture only from the vegetation on which it feeds. Broad hooves assist it in negotiating over sand and it will cruise through the desert, following rains to plant-covered dunes. The animal is sandy colored with white underparts. It stands about 42 inches high at the shoulder. The head and closely-ringed horns, with a spiral twist, can add up to another 42 inches.

The addax was last seen wild in Palestine in 1863, is reported extinct in Egypt since 1900, and has disappeared from Tunisia, southern Algeria, and Rio de Oro. It is said to be scarce now in the Sudan. Prior to World War II, its destruction was accelerated by Italian military patrols that machine-gunned the herds. A major last refuge for it exists in the Mali and Mauritania border region north of Timbuctu.

Belonging to a genus related to the addax, but less hardy though more abundant, is the scimitar-horned oryx. It is set off by long horns that gracefully arch backward on both sexes. The adult male stands about four feet at the shoulder and weighs 450 pounds. Its general color is white with a touch of chestnut on the face, neck, flanks, and upper limbs.

Less than a century ago this species was well distributed around the fringes of the Sahara from Senegal to the Nile. But it is now reportedly extinct in south Morocco, Algeria, Tunis, and Egypt, and virtually vanished in the Sudan. Depleted in the north, it still exists in relative abundance along a narrow southern strip running from Mauritania

The addax is at home in the desert — it obtains water from the vegetation on which it feeds, and it has broad hooves for travel over sand.



The Persian wild ass, or onager, has been a beast of burden for centuries, due to its speed and strength.

to the Red Sea. The total population may be 10,000, of which an estimated 4,000 are in Chad.

The scimitar-horned oryx avoids the desert heartland frequented by the addax. The meat of this animal is considered superior to any other wild animal and has been likened to top-quality beef. Additionally, its hide makes high quality leather.

The basic existence of the Haddad tribe of northern Chad centers on the oryx. Tribesmen hunt them with nets made of oryx leg tendons. Oil surveyors and troops also are partners to the uncontrolled hunting that, along with the encroachment of the desert, has contributed significantly to the decline of the oryx. Its survival is in jeopardy.

What price an oryx?

The smallest and rarest of the three species of oryx is the Arabian oryx *(Leucoryx).* It once ranged as far west as the Sinai and east to Mesopotamia but is now limited to the Arabian peninsula where mechanized slaughter by Arab sheiks and rulers, by oil companies, soldiers, and Bedouin has drastically reduced its numbers.

To save the animal from extinction, "Operation Oryx" was staged in 1962. Three specimens were caught and transferred to the Maytag Zoo in Phoenix. Later additions, donated by Arab leaders, have helped boost the number to a viable breeding herd of over 21. The Sheik of Qatar maintains a private zoo with about 45 Arabian oryx. Two other herds exist in the Los Angeles and Riyadh zoos.

Unable to deal over the Middle East political barrier, General Yoffe hopes to obtain a pair of the animals from the United States and reintroduce them to the Holy Land. Rock paintings of the oryx have been found at the ancient copper mines near Haibar. But purchase of this species is an expensive proposition. King Saud of Arabia bought a pair five years ago and paid $25,000.

The Arabian oryx is almost pure white with some dark markings on its face and legs. The horns are almost straight, with a slight backward curve, and up to 29 inches long. This oryx stands about 40 inches at the shoulder. It wanders through the *jol* — the gravel plain at the edges of sand desert — and can survive long periods without drinking.

The threat of motorized hunting

Another animal that has been badly mauled by uncontrolled motorized hunting and modern arms is the graceful dorcas gazelle, related to the Arabian gazelle but smaller and with much longer horns. It is a desert creature found in areas where acacia grow. Both Israelis and Arabs are guilty of its indiscriminate slaughter. During one five-year period, Israeli army officers killed some 1,000 gazelles in the Negev desert. The species is now fully protected by law in Israel and the present population, estimated at up to 500, is increasing steadily.

In Saudi Arabia, hunting parties and construction crews have ravaged the animal, once extremely common. Fairly large herds may still exist in the vast wastes of northern Arabia, eastern Jordan, and southern Iran, where the land is too rough to accommodate hunting on wheels.

The dorcas has short hair, running from a reddish brown on the back to fawn on the haunches. The long ears are a pale brown. Its face markings are similar to the Arabian gazelle but with the cheeks grayish instead of fawn. The horns are much longer, not lyrate, and less widely divergent from each other.

Through the attention of the NRA, a decimated hill gazelle population in Israel's Galilee region has been restored. Less than 200 were reportedly remaining in 1964. Placed under protection, they now number about 4,000 and some 500 have been moved to the Golan Heights of occupied Syria, where they had been completely wiped out.

Recovery of the Nubian ibex

The Nubian ibex, like the dorcas, has also made a remarkable recovery since coming under official protection in 1955. Found in the Judean and Negev hills, this spectacularly-horned wild goat was seriously reduced in the first half of the century with the introduction of modern firearms into the area. There are now over 1,000 in Israel, with several herds located in nature reserves, including Haibar. The reserve authority employs Arab Bedouin to catch infant ibex for incorporation into these herds.

The Nubian ibex, although considerably shorter than its Siberian counterpart, is a muscular animal with great crescent-shaped, knobbed horns that may reach 46 inches in length. So striking is this animal that its head is used as the insignia of the Israel Nature Reserves Authority. These ibex are colored brown, with dorsal stripe, throat, chest, and outer surfaces of legs black, and the underside white. They have a distinctive white band around each leg, and dark tail and chin tufts.

About 2,000 of them live in the Red Sea hills of Sudan, where they are also protected. The ibex range extends to the Sinai, Syria, Arabia, and upper Egypt, but no figures are available on the numbers in these areas. In Saudi Arabia, it may be the only large wild animal not in danger of disappearing.

Gone from the scene is the Syrian wild ass *(Equus hemionus hemippus)* that once inhabited the biblical landscape. This animal, the smallest of the five races of Asiatic wild ass, roamed widely over the Fertile Crescent area. None, however, have been seen since 1927. The remaining races are all endangered, a factor not ameliorated by their habit of breeding only once every three years. They all have similar features including a sandy colored coat, white bellies, a dark spinal stripe, large ears, erect mane, and a tufted, black-tipped tail.

The Haibar reserve acquired a number of onagers *(Equus hemionus onager)* which are slightly larger but most similar to the extinct Syrian variety. The onager stands about 44 inches high. It once ranged broadly across southern Russia and Iran. But severe winters took a sharp toll of their numbers. Over the centuries, this animal has been much in demand. It has great speed, can carry far greater loads than the domestic donkey, and its meat is quite tasty.

The onager's speed was such that in the past it was hunted down by relays of horsemen. More recently, it was shot from cars, and this has hastened its decline. Only about 700 are left in the Badkyhz Reserve in the Soviet Union and another several hundred are believed remaining in Iran, where it is still hunted illegally.

General Yoffe and his nature authority plan also to introduce desert wolves *(Canis lupis)* and the caracal into the Haibar park. They will be quartered in pens and fed with meat from a nearby kibbutz.

Yoffe hopes to obtain funds in the near future that will enable him to establish roads, signposts, observation towers, and visitors' facilities in the park. After the visitors' facilities are completed, he hopes to create another reserve in Israel's hilly north for endangered animals that once frequented the heights of the Holy Land. "But that is only a dream," he admits.

Animal Kingdom Reports

NYZS photo by Bill Meng

Some of the largest and most colorful sea creatures to be seen at the New York Aquarium reside not in the water but on a mural of ocean life, painted on the Boardwalk face of the aquarium's administration building at Coney Island. The mural, which is 132 feet long and 16 feet high, was adpated from individual paintings created and executed by children from Brooklyn public schools.

HUGE OCEAN-LIFE MURAL PAINTED BY CHILDREN AT NEW YORK AQUARIUM

At the New York Aquarium a large mural of ocean life has been painted on the boardwalk face of the aquarium's administration building at Coney Island. The mural, which is 132 feet long and 16 feet high, was adapted from individual paintings created and executed by artistically talented children from Brooklyn public schools.

Under the direction of Elie Aliman, the aquarium's graphic designer, and Karen Hensel, aquarium zoology specialist, the project was sponsored jointly by the New York Zoological Society, which operates the New York Aquarium, the Brooklyn Arts and Culture Association (BACA), under the directorship of Charlene Victor, Abraham & Straus, and the Board of Education Bureau of Art.

The mural is based on art work of students from the elementary grades through junior high school chosen in a borough-wide competition. Many of the young students whose art work was selected also helped to paint the mural. They were assisted not only by the aquarium's personnel, but also by artists from BACA and Pratt Institute, who had been encouraged to contribute their work by Charlene Victor.

Aquarium Director Dr. James A. Oliver and August Heckscher, Administrator of Parks, Recreation and Cultural Affairs for the City of New York, dedicated the mural on June 20, in the presence of many of those who helped to create it, as well as the executive committee of BACA.

BRONX ZOO'S PERE DAVID DEER HERD CONTINUES TO GROW

Of all the attractions at the Bronx Zoo, perhaps the one most interesting to a visitor from the People's Republic of China is the breeding herd of Pere David deer. These "most individual deer," which once roamed over northeastern China, are extinct in the wild and today exist only in zoological parks. This spring five fawns were born at the Bronx Zoo, and the herd now numbers 21 animals.

It is therefore not surprising that when three Chinese officials came to the Bronx Zoo in April, they made a special visit to the Deer

Range to view the Pere David deer. Members of the official party that escorted the giant pandas to their new home at the National Zoo in Washington, D.C., the visitors to New York were Ma Yung, advisor to the Peking Zoo; Ping Hung, director of the Bureau of Public Services of Peking; and Chiu Sheng-Yun, official translator.

The common name in Chinese for these deer is "ssu-pu-hsiang," or "mi-lou," meaning "four unlike characters." The name derives from the Chinese description of the animal, which is said to have antlers like a stag, feet like a cow, a neck like a camel, and a tail like a donkey.

In the western world, the species is known as Pere David deer, after Father Armand David, a French missionary-naturalist, who was the first European to see the remnant herd in the Imperial Park near Peking in 1865. This herd, which Father David estimated at the time to consist of over 100 animals, was all that remained of the numbers once distributed over northeastern China.

Although no foreigner was allowed in the Imperial Park, the intrepid Father David not only managed to see the animals by "climbing on the wall," but also obtained "with money and trouble" several skins which he sent to the Museum of Natural History in Paris in 1866. Professor Milne-Edwards, director of the museum, described the specimens as a new genus, *Elaphurus,* and gave them the specific name of *davidianus* after Father David.

In 1869 a young pair was sent to the London Zoo as the gift of Sir Rutherford Alcock, British Minister at Peking. These were the first living Pere David deer to be seen in Europe. Other specimens arrived soon after in Paris, through the good offices of the French Minister, M. de Bellouet, who had requested them from the Chinese government upon the repeated urgings of Father David.

The Imperial herd in China was killed during the Boxer Rebellion in 1900, reportedly by soldiers of the western allied troops quartered in the park, who sold the meat to the famine-stricken populace. After this, only scattered specimens were left in European institutions and a few in Peking, where the last died in 1921.

Fortunately for the species, in 1898 the eleventh Duke of Bedford had established a small herd at Woburn Abbey, a walled park of approximately 4,000 acres in England. To this original herd, he added the remaining specimens from the European zoos. The herd thrived and in 1948 numbered 300 animals. From this nucleus, breeding pairs were acquired by many of the world's larger zoos. The species was returned to China in 1956, when the Peking Zoo received four specimens from England's Whipsnade Park. A fawn was born the following year in Peking, but later records are not available. However, it is known that a few specimens are presently on exhibit at the Peking Zoo, but that they are not breeding.

The first Pere David deer in the United States were two pair received at the Bronx Zoo in 1946. The zoo's first fawn was born in 1949, and there has been regular breeding to date.

A Pere David deer fawn, one of five young born at the Bronx Zoo this spring, stays close to its mother on the Deer Range. The zoo's herd now numbers 21 animals. Extinct in the wild of their native China, Pere David deer today exist only in zoological parks.

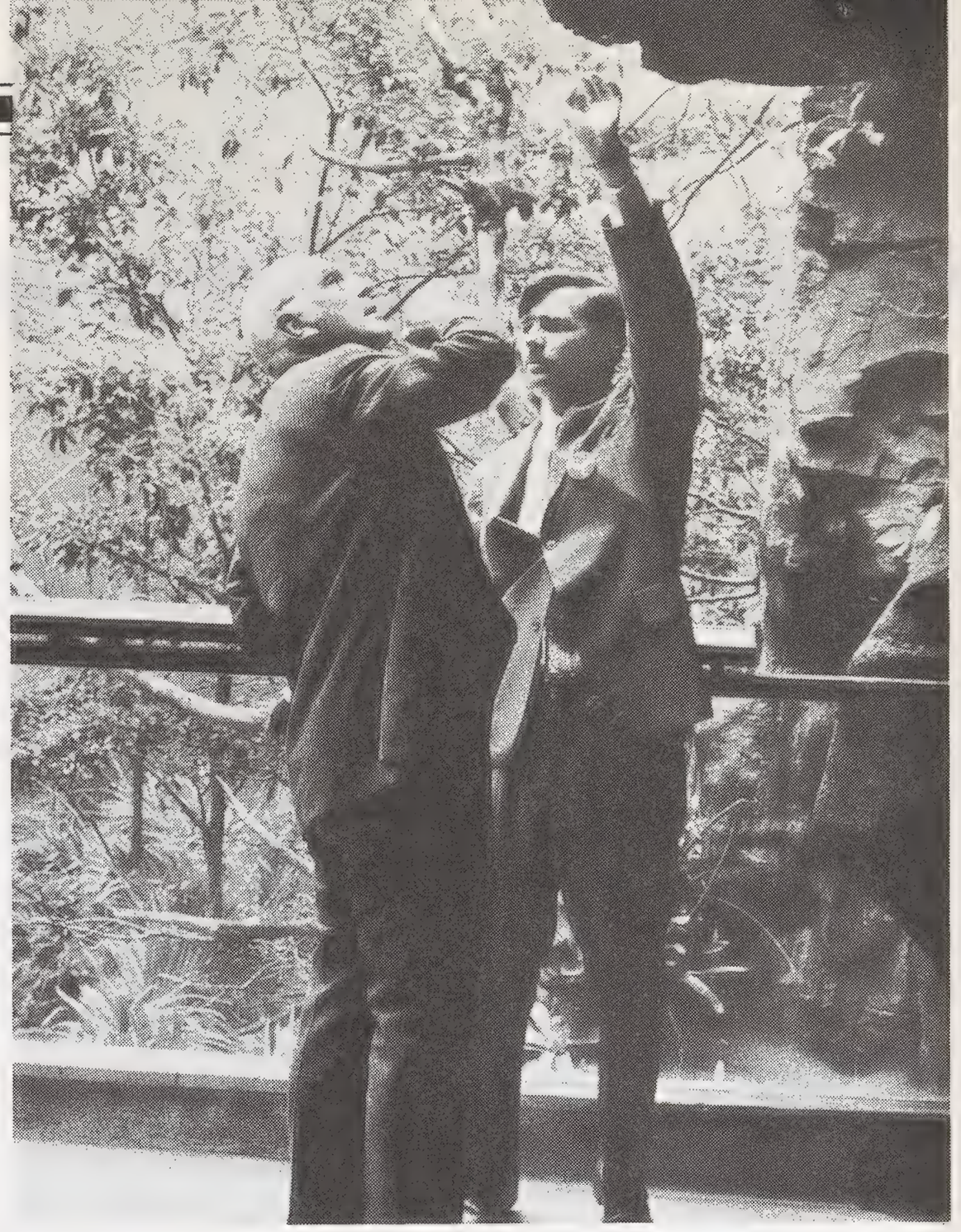
NYZS photo by Bill Meng

THE COSCOROBA, A FOOTNOTE TO NEW YORK ZOOLOGICAL SOCIETY HISTORY

The coscoroba *(Coscoroba coscoroba)* from southern South America and the Falkland Islands is a large waterfowl related to the swans and the whistling ducks. It resembles the former in size and coloration, and the latter in general physical proportions. Because of its beauty and apparent affinity to both of these groups, the coscoroba has long been a favorite for waterfowl collections. Described by Molina in 1782, the first live specimens were exhibited at Regents Park (London Zoo) in 1870, and the first captive breeding took place at England's Woburn Abbey in 1910. Since that time only a few collections have been fortunate enought to breed, or even maintain, this interesting bird. The first American breeding success took place at the Philadelphia Zoo in 1948, and a prolific breeding group has become established at the San Antonio Zoo in Texas.

The history of the coscorobas at the Bronx Zoo is of particular interest because they were among the earliest acquisitions to the society's bird collection; four coscorobas from Brazil arrived on October 2, 1899, just a little over one month before the zoo opened to the public for the first time. Fourteen additional coscorobas have been exhibited here in the intervening 72 years, but never with any serious attempt to breed them. Three coscoroba chicks hatched in April 1972 are the first to be hatched and reared here. The parents are progeny of the San Antonio Zoo's breeding group.

Joseph Bell



NYZS photo by Bill Meng

Dr. Bernard Grzimek (above, left), director of Germany's Frankfurt Zoo and a Gold Medalist of the New York Zoological Society, was given a preview tour of the World of Birds by the society's general director, William G. Conway, during a visit to New York City in June. The visit coincided with the publication of the English-language edition of "Grzimek's Animal Life Encyclopedia," thirteen volumes on the animal kingdom from the lower animals to the mammals, edited by Dr. Grzimek and published in the United States by Van Nostrand Reinhold Company.

A coscoroba chick, a bundle of fluff when photographed at the Bronx Zoo shortly after hatching in April, will have white feathers as an adult, with black wing tips, red bill, and pink feet. A good swimmer and flier, this South American bird takes off almost straight up from water or land.

NYZS photo by Bill Meng

SUMMER, FALL WINTER, SPRING . . .

any season is the time to join the ranks of volunteer guides for the Bronx Zoo, the Central Park Zoo, and the New York Aquarium. Training sessions start several times during the year. Weekday and Saturday classes are available. For more information, call the Volunteer Services Office at the Bronx Zoo (933-1500, Ext. 78) or the New York Aquarium (266-8500, Ext. 40) - before another season goes by.

In the April 1972 issue of ANIMAL KINGDOM, the elephant photograph on the top of page 13 should have been credited to Dietrich Schaaf.

Bookshelf

A BEACHCOMBER'S BIBLIOGRAPHY

With summer here and sun and surf on people's minds, a short list of books that will help the layman understand one of nature's richest habitats – the intertidal zone – seems in order.

Parents will find many projects for young children in *A Beachcomber's Book* by Bernice Kohn ($3.75, Viking Press, New York, 1970). This book contains a smattering of natural history, plus craft projects that children enjoy such as shell and pipe cleaner sculpture. Recipes are included for beach plum jam and bayberry candles.

An illustrated pocket-sized survey of all seashore life is found in *Seashores, A Guide to Animals and Plants along the Beaches* by Herbert S. Zim and Lester Ingle ($1.25, Golden Press, New York, 1955). This is an excellent beginner's field book, as it enables rough classification of most common plant and animal specimens without the confusing technical detail needed for determining exact genus and species.

Mollusks are perhaps the easiest group of marine animals for amateurs to collect and study. We recommend that attention be paid to natural history and behavior of the living animal rather then simply the collection of mollusk shells. As a start read *Wonders of the World of Shells* by Morris K. Jacobson and William K. Everson ($3.95, Dodd, Mead & Co., 1971). This young people's introduction to mollusks emphasizes the living animal. For a comprehensive shell field guide, we recommend *Seashells of North America* by R. Tucker Abbott ($3.75, Golden Press, 1968). This guide is beautifully illustrated, entirely in color, and contains a description of habitats and habits, as well as identifying characters for 850 species.

– Robert A. Brown

THE ENDURING BEAST.

Edited and Illustrated by Miriam Beerman. 64 pages. Doubleday & Company, Inc., Garden City, New York, 1972. $4.95.

Miss Beerman has selected 25 poems and prepared nearly as many illustrations to produce this book. As the title indicates, animals are the subject of the poetry and Miss Beerman's art; a great, sad-eyed sea turtle accompanies Gregory Corso's "Giant Turtle," a fast-moving mustelid swims across two pages leaving just enough room for Marianne Moore's "The Wood-Weasel," and a soft-nosed rabbit faces the page on which Robert Frost's "The Rabbit Hunter" is printed.

Miriam Beerman's painting style does not produce literal interpretations, although her animals are identifiable. Rather, by using broad, fluid brush strokes and subtle, subdued tones, she captures the character of the animal she is portraying and its feeling of solidness, motion, gentleness, boldness, or strength. She does this extremely well, and art and poetry are combined here to produce a lovely, well-designed book.

–Dorothy Reville

NO FURTHER RETREAT:

The Fight to Save Florida.

This is an excellent book about a sad topic – the slow, almost cancerous, destruction of a beautiful state through poor environmental management, political shenanigans, and short-sighted greed. In the first few chapters the author discusses the geological and biological history of Florida, to set the stage for what has happened since Europeans began settling there. He then briefly reviews the early pioneers in the state and the present-day Floridians, and their politics. Each following chapter explores a different ecological disaster in the making or after the fact.

The problems of draining and filling coastal estuaries is probed. The successful efforts to drain, dike, and divert the waters of the Everglades by the Army Corps of Engineers and the state flood control agency are described, along with how these created artifical droughts for South Florida and the Everglades National Park. The Florida Keys are discussed, together with the continuing destruction of their unique flora and fauna through uncontrolled land and housing development and from thermal pollution from electrical generating plants.

Other Florida islands are also mentioned, because they have not been subject to the same systematic environmental degradation. These are cited as examples of what can be done with a proper concern on the part of the land owners. The grandiose plan to dig a barge canal across north-central Florida is briefly held up to scorn as the pork-barrel boondoggle that it is. The problems resulting from the release of foreign species of plants and animals into the wilds of Florida is touched upon.

Finally, the reason that all the ecological problems have come into being is set forth. It is the title and subject of chapter eleven, "No one is in charge." Ecologists were not available to explain the interrelationships of the biological and physical world and how changing one aspect of that world also causes changes in other parts. Without this knowledge, no one cared. They were not required to care. Individuals owned the land; they did what they wanted with it. And the state and federal government did what they wanted without worry. Forests were cut, wetlands drained, houses built, streams and estuaries polluted, pesticides used indiscriminately, and immigration encouraged. Each person or governmental agency acted somewhat independently, or so they thought. No one was in charge, so the problems developed.

In the discussion about monetary profit and moral obligation or ecological concern, one point made by the author is so important that I wish to call it to the reader's attention here: "To ask any agency, public or private, to be judge or monitor of its own activities is to invite disaster." Instead, "we must take the decision-making authority, or power to exercise a major influence upon decisions, away from those who would in any way benefit from the decision."

The author has done a remarkable job of illustrating the ecological problems Americans have created in Florida. However, the book is so short that not one of the topics is discussed in depth. In each case, only enough background facts are presented in a matter-of-fact manner to enable the reader to understand the problem, and one might have hoped that the author would at least have touched on the aesthetics of wilderness and wildlife.

Nevertheless, this book is recommended to anyone interested in studying several aspects of the ecological plight of one state. It does not tell a happy story. It calls for understanding and action on the part of the reader, for as the author notes, "In 1970, wilderness, or even wild country, is in short supply. Where do you go when all the fair places have been ruined? Where do you go from Florida?"

– F. Wayne King

COME WITH ME TO THE EDGE OF THE SEA.

By William M. Stephens. 80 pp. Julian Messner, New York, 1972. $5.50

William M. Stephens, once associated with Miami Seaquarium, has written an excellent children's book and illustrated it with his own lively photographs.

Stephens makes his youthful readers think by asking them to check for themselves such things as whether resting gulls face into the wind or away from it. There is also good advice on why seashore creatures should be left in their natural habitat instead of subjecting them to certain death by taking them home.

He tickles the senses of the readers, making him look, smell, and listen. "Have you ever listened to sand?" he asks. "What are the different sounds? The roar of the sea . . . people talking and walking . . . the call of seabirds . . . perhaps a passing airplane."

The undefined terminology sometimes gets heavy (*tsunamis,* for example), but the pace and enthusiasm never falter. I very much like a book such as this one, though perhaps out of prejudice. You see, I've been sand-listening for years.

Stephen Spotte

"...when the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can be again."
– William Beebe
First curator of birds, Bronx Zoo

Vanishing Species

THE BROWN PELICAN
Pelecanus occidentalis

The brown pelican is in danger. It is the state bird of Louisiana, but has not bred there since 1961. In 1968, only two pairs bred along the entire coast of Texas; none since that time. The Mississippi population has never been large, but so far is holding its own. Colonies in the Carolinas and in Alabama are stable at present, although the outlook is not promising. Strangely enough, the brown pelican has never bred in Georgia, as far as we know.

The primary reason for the decline has been accumulating pesticides (especially chlorinated hydrocarbons) in marine food chains. These substances are first absorbed by plankton, then by successively larger creatures, such as the fishes upon which pelicans feed. Each step up the chain represents the sum total of pesticide in all the previous steps. The pelican, being at the very end, gets it all.

According to National Audubon Society statistics, the most dramatic decline in brown pelicans has occurred along the coast of California. Prior to the late 60s, California supported a sizeable population of birds. In 1968, however, no breeding birds could be found anywhere in the state. Tissues of a specimen collected two years before showed a DDT content of 84 parts per million.

Pesticides – notably DDT – cause decreases in eggshell thickness in many sea birds. Species indigenous to heavily contaminated areas produce significantly thinner eggshells. Distinct correlations have been found in the white pelican and herring gull; presumably a similar mechanism is at work in the brown pelican.

In 1969 at Anacapa, 298 nests were counted. Intact eggs were seen in only 12 nests; nine nests contained a single egg and three others contained two eggs. Of the total number of nests, 51 held single broken eggs. The shells of these eggs were soft and definitely abnormal.

A second colony on Anacapa proved no more viable. Of 339 nests investigated by biologists in 1969, only 19 contained intact eggs. Fourteen nests had one egg, four nests held two eggs, and only one nest contained three eggs. This colony, as in the case of the first, was a reproductive failure.

Healthy pelicans produce two to four bluish-white eggs with rough texture. Incubation is from four to six weeks with both parents sharing the duties. The young are born helpless and blind, but after two weeks acquire white coats of down. Young birds are fed on fish regurgitated from their parents' gullets. Contrary to popular belief, the pouch is not used to store food. It is used as a cooling organ. On hot days, pelicans open their mouths and shake the pouch back and forth, thus helping to lower the body temperature.

The presence of people disturbs nesting pelicans, but even in the seldom-visited islands of the Gulf of California, they are producing thin-shelled eggs. It would appear that until a dramatic turnaround takes place in oceanic food chains, the DDT level in pelicans will continue to increase, meaning an eventual end of the western populations.

In the U.S., only parts of Florida support sizeable breeding colonies. From the tip of the peninsula southward through the Keys, pelicans are a common sight. But even here they may be living on borrowed time. Recent studies show a steady, almost imperceptible decrease in eggshell thicknesses.

Brown pelicans everywhere are long-lived, so a decline in population goes unnoticed for a time. Breeding attempts may be unsuccessful for years, yet the parent birds continue to haunt familiar territory, giving the illusion of viability. Then suddenly they are gone.

To casual observers, brown pelicans seem an integral part of the seashore fauna. It is difficult, in fact, to visualize a southern coastline without its resident brown pelicans squabbling over an old piling, or gliding in military formation just above the surface of the sea. But not much more than a century ago, who could have pictured a midwestern sky without passenger pigeons, or a vast plain empty of bison?

– Stephen Spotte

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Back: The red-backed cleaning shrimp *(Hippolysmata grabhami)* is named for its habit of grooming fish to remove parasites.

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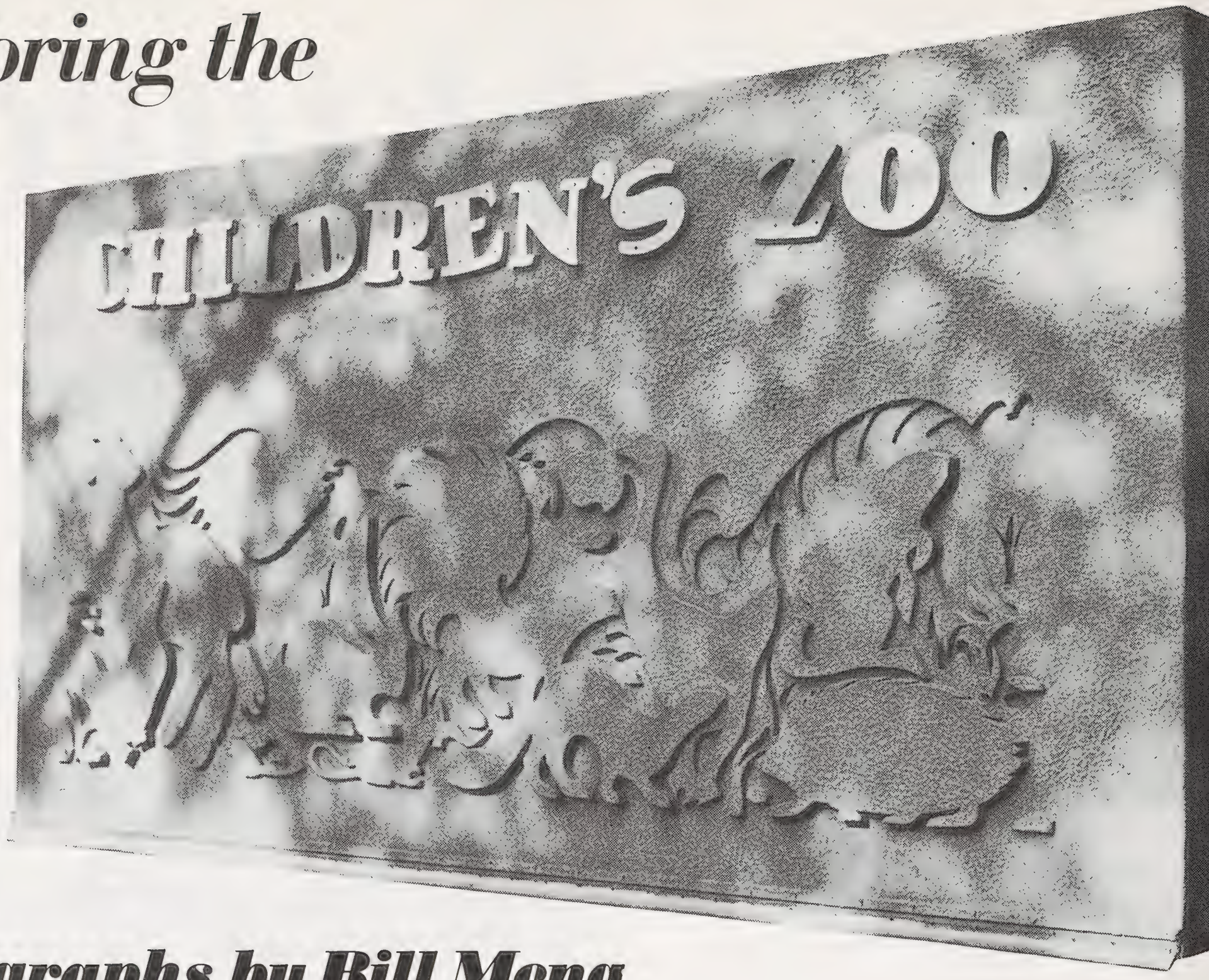
Exploring the



Photographs by Bill Meng

The Children's Zoo at the Bronx Zoo is an educational adventure for children, where they can come face to face with the more common animals, such as a rabbit (at right), and the less familiar ones, such as a tamandua, a prehensile-tailed anteater (at left).

Smell Me

The "Smell Me" sign does not refer to the African pigmy goat; that youngster just climbed up to get a closer look at the children who are engrossed in smelling animal scents enclosed in special "sniff" boxes (at left).

Inside special "Look" boxes are small animals, such as the sweetweb weaver spider (below, top left); and at the porthole, children can listen to the sound of an angry rattlesnake (below, right). The "Gerbil Shell Game" is all guesswork; behind which shell — oyster, clam, or mussel — will the gerbil be found? The child makes a guess, then looks to see. One box holds the gerbil; the other two are empty (below, bottom left).

The children's question "What is it?" can be answered by the parents who find the information on adult-level signs (below, left). But first the children reach in and feel an inanimate animal object, such as a turtle shell, and try to guess what it is, based solely on the sense of touch (below, right). New-born mice are small, pink, and hairless, and a source of fascination to any child (at right). It is all part of the adventure at the Bronx Zoo's Children's Zoo.

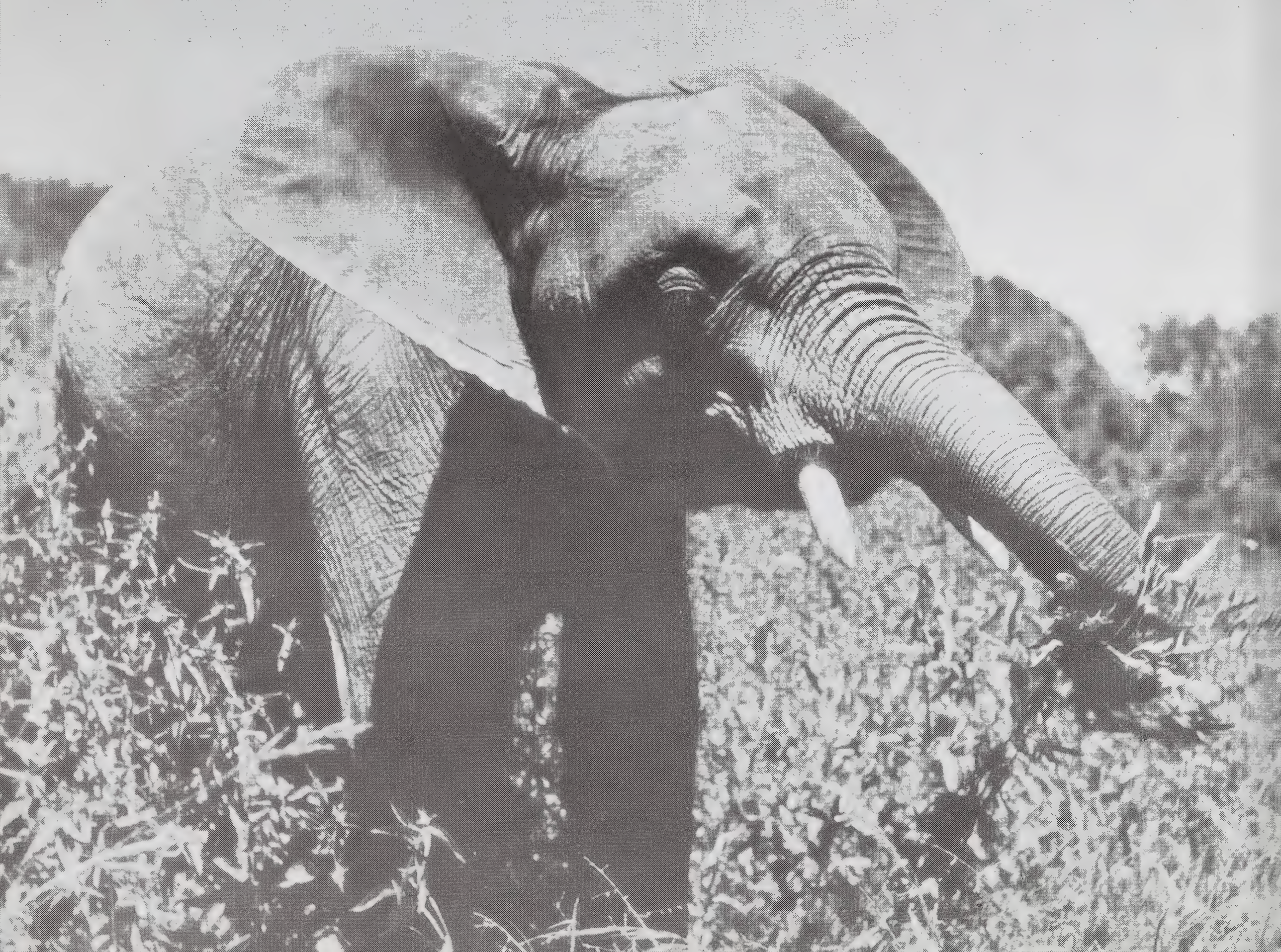
ELEPHANTS,

Fire, and the Environment

by Dietrich Schaaf

A versatile feeder, the African elephant eats all matter of vegetation, including herbs, leaves, twigs, fruit, bark, and roots, but grasses form the animal's staple diet.

The snow-capped crown of Mt. Kilimanjaro looms majestically through the clouds over East Africa.



Elephants have been called the plowmen and path-makers of Africa. African elephants eat all manner of vegetation – grasses, herbs, leaves, twigs, fruit, bark, and even the roots of trees that they push down. In feeding, elephants may break and uproot trees and bush, and strip bark from standing trees. Their activities in combination with seasonal fires, both man-made and naturally-occurring, help create and maintain the grassland and savanna environment found in much of East Africa and Central Africa.

We may consider the feeding habits of elephants "creative" in that historically they helped to maintain a type of environment. Today, however, elephants often are restricted in their movements to within parks and reserves, because of pressure from the growing human population and a concomitant increase in land use, which often extends to the very boundaries of the protected areas.

Elephants once ranged Africa widely and probably no one area was used excessively by them. Their numbers have increased in recent years in protected areas, both by recruitment and by immigration from areas where elephant and human interests come into conflict. For example, in 1966 and 1967, 2000 elephants were cropped from the extremely large herds in the Murchison Falls Park of northern Uganda. The director of the cropping operation felt that the cropped animals soon would be replaced by animals moving into the park from the north, where they are at odds with local agriculturalists.

There has been an increase in numbers of elephants beyond the carrying capacity of the land, and this has resulted in habitat degradation from increased feeding pressure in combination with fire, an important ecological factor in many parts of Africa during the dry season. Where woody vegetation is damaged – for example, when elephants have stripped bark from trees – it tends to be more susceptible to death by fire. This is true even of species of trees that live in communities developed under the influence of fire and which are generally considered "fire-hardy." In areas where elephants already have killed trees or prepared them for destruction by fire, frequent burning favors a relatively few species of fire-hardy

grasses and shrubs, often unpalatable to grazing animals except when newly sprouted. Thus the diversity of the natural community is greatly reduced.

Due to their size and to a relatively inefficient digestive system, elephants consume large quantities of food, although it amounts to relatively little per unit of body weight. The full stomach of an elephant is about five or six percent of its body weight, which is around 5000 pounds to 8000 pounds for adult animals in northern Uganda. In an experiment with oranges fed to a tame animal, most of the remains appeared in the dung from 11 to 14 hours later. On this somewhat tenuous basis, it can be estimated that the stomach is emptied on an average of once every 12 hours. Since elephants spend a large part of every day and night feeding, one might guess that the somach is emptied one-and-one-half times in each 24-hour period to obtain a very rough estimate of daily consumption.

In the late 1950s, scientists made aerial counts over 1500 square miles of Uganda, including the southern two-thirds of Murchison Falls Park, an area with a serious elephant problem. The average population over a 32-month period was estimated at between 7000 and 8000 individuals. It is easy to see that the food intake of the Murchison Falls population alone could exert considerable influence on the habitat.

Investigation of the relative importance of different types of vegetation in the elephant diet indicate that roughly 75 to 90 percent consists of grasses, the variation no doubt being due to locality and season. Food material from the stomachs of 71 animals was collected by Dr. Irven Buss during the dry season of 1958-1959 near Murchison Falls Park. It consisted of 88 percent grasses, while leaves, twigs, and fruit constituted 10 percent, and herbs made up the remaining two percent. Additional work done by others in Tanzania and South Africa revealed similar proportions of grasses and other vegetation in the diet.

Although grasses form the major portion of their food, elephants apparently also need browse, and they may sometimes crave other vegetative parts, such as bark, fruit, or roots. The elephant damage which concerns conservationists and park authorities today results primarily from feeding on woody vegetation. In 1947, ecologist W. J. Eggeling, writing of the Budongo Forest just south of what is now Murchison Falls Park, noted that numerous forest nuclei around the Budongo were battered and broken by elephants. He stated that "it is indisputable that wherever they occur in numbers, elephants are a limiting factor to natural development of the vegetation."

A detailed study carried out by H. K. Beuchner and H. C. Dawkins in Murchison Falls Park in the late 1950s documented the conversion of *Terminalia* woodlands and *Cynometra* rainforest to treeless grassland through the combined action of elephants and fire. Study plots were laid out in the woodland and almost all the trees examined within them showed recent damage or old scars from debarking by elephants. Many were in a low state of vigor or dead.

In the southeastern section of the park, a small stand of rainforest, isolated and completely surrounded by grassland, was examined. Trampling and breakage by elephants around the forest edge creates snags of dead vegetation and encourages growth of grass, both of which burn readily in the dry season. Within the forest, *Cynometra alexandri,* the Uganda ironwood, is the dominant tree species, and elephants frequently strip it of bark.

The small size of this forest, combined with the

The elephant's trunk is in reality a prolongation of the nose and upper lip, with the nostrils at the tip. It serves as a prehensile hand in selecting food and conveying it to the mouth.

continued effects of elephants and fire, have altered conditions of shade, temperature, and humidity needed for regeneration by some of the tree species. The forest is slowly dying. Isolated giant forest trees here and there in the extensive grassland also attest that once forests were more widespread in this region.

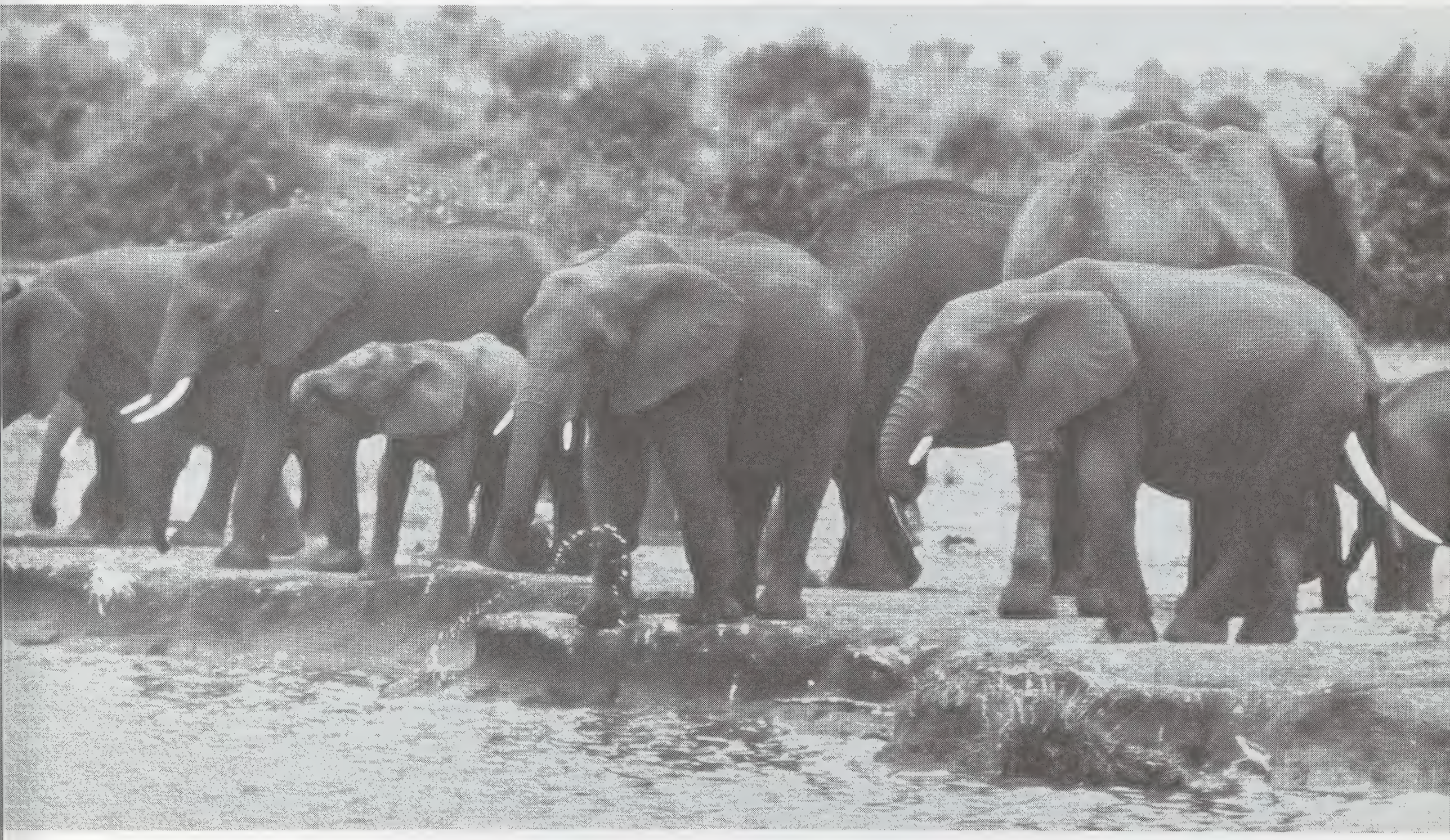
Although there is a marked dry season, the average 45 inches of annual precipitation is sufficient to support more luxuriant and varied vegetation, especially in depressions or along water courses. Exclusion plots in the grassland, designed to keep out elephants and fire and to allow the vegetation to develop undisturbed, show changes in a season or two, with an increase in small bushes and trees.

There are many examples of similar investigations in the scientific literature. One of these was undertaken in the Serengeti National Park of Tanzania, where according to records left by early travelers and hunters, elephants were not found prior to 1956. Here again, it is probable that human activity outside the park caused the animals to frequent its more heavily wooded northern and southern sections. The elephants have damaged the trees there considerably, although perhaps they are not yet an immediate threat to the habitat in this region.

To date investigators have amply recorded and described the interaction between elephants, fire, and vegetation, but unfortunately there has been little attempt to experimentally manipulate the environment so that the relative components of elephant and fire damage can be separated and quantified, a logical next step in analyzing the system. The failure to experiment is due in part to the difficulty of manipulating such a system, yet the detailed information upon which management schemes might be based will not be obtained until this is done.

The damage done by feeding elephants, where not excessive (and we have yet to define where the line should be drawn), is important in maintaining certain habitats. Sometimes what at first appears to be excessive destruction has unexpected after effects. Early in the last decade, the Tsavo National Park of Kenya suffered severe damage to woodland through a combination of elephant feeding and unusually prolonged drought. Today rainfall is again normal and a new type of vegetation

The elephant herd, here shown at a water hole, is based on the cow-calf family unit and is led by a matriarch, usually the oldest cow.



has developed with a higher carrying capacity for plains game. Oryx, zebra, eland, hartebeest, buffalo, and other species seem to be increasing. This is in marked contrast to the extensive grasslands created by elephants and fire in the southern half of Murchison Falls Park, where only a few ungulate species are regularly seen.

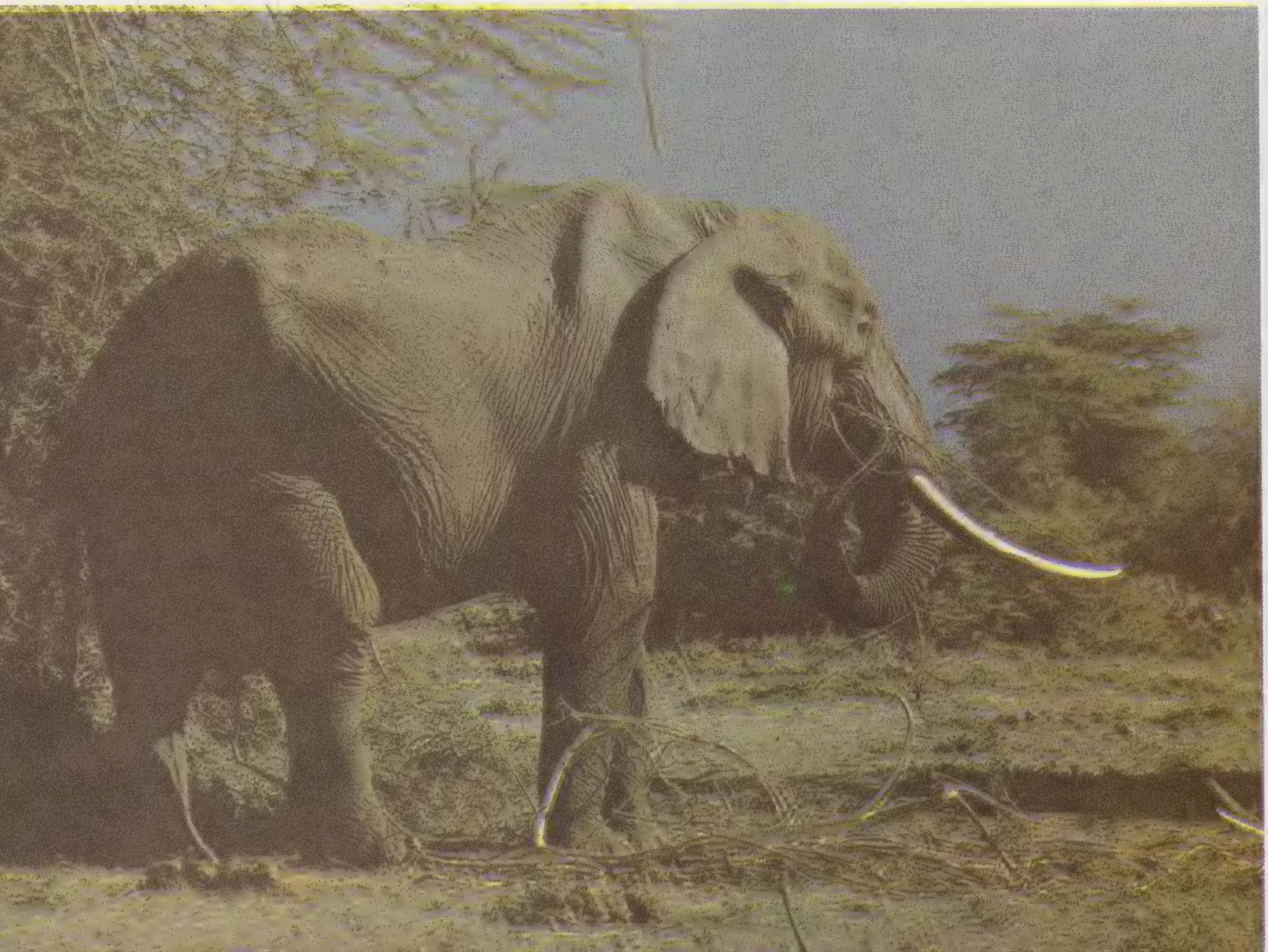
Another aspect of elephant activity, which may be considered "creative" without the potential for "destruction," is the scattering of seeds from a variety of plants in elephant dung. There is good evidence that the seeds of some species of *Acacia*, an important group of dry country trees throughout Africa, need to pass through the digestive tract of an herbivore in order to germinate. Elephants are not the only animals which perform this function, although they are often able to reach seed pods high in trees inaccessible to other animals.

This aspect of elephant activity is generally much less obvious than the destructive nature of their feeding habits. I know of one good example of habitat undergoing change in which elephant seed dispersal, feeding habits, and fire all play a part. Elephants relish the fruit of the borassus palm, and the large kernel-like seeds are dropped about the countryside with their dung. In Murchison Falls Park there are several small groves of mature trees which serve as a source of seeds, and in the surrounding grassland literally thousands of young plants grow, each no more than a clump of fronds four or five feet above ground level.

Annual fires often severely damage the foliage, while elephants themselves sometimes eat the new fronds that sprout as a result. Borassus palms seem to spend a number of years before starting a stem, because of fire and to a lesser extent because of elephant damage, and a period of freedom from fires may be necessary while the trees attain their first 10 feet of height. Should fire be prevented from sweeping this area, a forest of borassus palms might develop.

It is interesting to note that there are virtually no intermediate size trees, only mature individuals and clumps of fronds. This would indicate a recent

It is the woodlands that African elephants can be most destructive of their environment, ripping branches off trees and stripping off the bark and eating it.



change in habitat, prior to which trees were able to reach maturity, and after which new trees have been unable to develop. Elephants are responsible for distributing the seeds, and help to keep young trees from developing. They may also have been responsible for creating conditions more favorable for fires which annually stunt the palms.

The consequences of the habitat changes discussed here are clear: there are parks set aside for wildlife conservation in which elephants are congregating and making the environment less suitable for themselves and many other species, thus defeating a primary purpose for which parks were created, that of preserving a portion of the environment as a living nature museum for today and the future. There is little doubt that if present land-use trends continue, parks and similar reserves will one day be the last stronghold for many large animal species in Africa.

If we agree that wildlife conservation is a worthwhile pursuit, then it becomes of the greatest importance that we learn to control factors destructive of park habitat. Elephant damage must be checked, and fire must be controlled and used

Elephants once ranged widely over Africa, but today they are limited mostly to protected areas.

Too-frequent burnings, whether natural or man-made, destroy the diversity of the natural community. Elephant damage causes woody areas to be more susceptible to death by fire.

Elephant tusks are actually a single pair of upper incisor teeth that are greatly elongated. Both male and female African elephants have tusks.

as a tool to maintain the habitat, instead of sweeping the countryside clean each year.

At present, the only feasible way to control elephant damage is to crop the animals so that numbers are brought into line with the ability of the environment to support them. This can be done efficiently in only a few ways. In Murchison Falls Park, elephants are shot by skilled hunters. The meat finds a ready market locally. Tusks, skins, and other valuable by-products are also sold. There is no waste of this wildlife resource, and proceeds from the operation are plowed back into park management. In Zambia's Lwangwa Valley, a limited number of elephants are cropped each year and processed in a small factory built for the purpose. The meat is shipped to the protein-hungry Copper Belt in the north of that country.

The most recent and perhaps humane method of cropping is being developed in Kruger National Park in South Africa. Animals are cut out of the herds with helicopters and then darted with an overdose of tranquilizing drug. The elephant collapses painlessly and dies, and the meat, if immediately processed, is not rendered unfit by the drug for human consumption.

Fire control presents a different problem. Obviously some burning is desirable. For the most part our knowledge is still too incomplete to say how much, when, or where. Fire prevention among people living near a park is important, for it is virtually impossible to control fires set inside and outside a park of several thousand square miles with the limited resources available. Perhaps ultimately some sort of education program will help lessen man-made fires, but it is unrealistic to hope for any change in traditional burning pat-

The African elephant flaps its large, fan-like ears to cool the blood as it flows through them.

terns in the near future. In the meantime park officials must wage a holding campaign by bulldozing firebreaks at strategic points, by breaking up the terrain with more roads and tracks which tend to act as firebreaks, and by burning firebreaks as early in the season as possible while the vegetation is not yet completely dry. Critical areas, such as threatened woodlands, must be watched most carefully, protected by firebreaks, and perhaps even put under guard during the dry season.

Are cropping and fire control appropriate in national parks? A park is, after all, an area set aside to preserve the natural scene, and the argument has been advanced that the elephants should be left to work out their own fate, and fires should be allowed to burn as they have done for millenia.

Unhappily we are caught upon the horns of a dilemma, for if we wish to conserve the wilderness character, the face of the land as it was without modern man, we should ideally interfere as little as possible. However, the amount of land available for wilderness areas, such as are found in the parks of East Africa and Central Africa, is today relatively small, and the environment within them is subject to stresses which are new. Fire and elephants, although part of the natural scene, are now being "overdone," as it were, and in the long run may be just as destructive of park objectives as the agricultural or pastoral development of park land.

We are forced to choose the lesser of two evils and learn to manage the wilderness, in some ways a paradox. Yet if we do not control problems such as those outlined above, parks will be destroyed. What would have been a minor incident when a whole continent was covered with wilderness would today be an irreplaceable loss.

DEATH *in a Small Package*

The Blue-ringed Octopus

by U. Erich Friese

"Shortly after midday on June 21, 1967, three army recruits who had enlisted the previous day were walking along the rocks about 300 yards off Camp Cove beach, near Sydney (Australia). One of them, aged 23 years, found a purple-colored octopus which he placed on the back of his left hand and showed it to his companions. He had it on his hand for some 10 minutes, when he complained about feeling rather dizzy, and found that he could not remove the creature, which was then pulled off and thrown out to sea by one of his companions. Within a few minutes, the young man stated that he was unable to swallow and could not breathe through his mouth. By the time he had been carried back to the army camp, he was unconscious and had not been breathing for some time. Mouth-to-mouth resuscitation was applied, together with external cardiac massage. Treatment was continued while in transit to Prince Henry Hospital, Little Bay, Sydney. Despite intensive attempts at resuscitation, the victim failed to respond and was declared dead at 1:45 p.m., which was some 90 minutes after he had picked up the octopus.

"Post-mortem examination revealed no abnormalities, other than some degree of pulmonary congestion. Two minute, faint bruises were seen on the second knuckle of the left hand, but no laceration of the skin could be seen. Examination of a section of the skin showed that the bruising lay in the dermal tissue only...." So reads the official account of a tragic encounter between an Australian beachgoer and a tiny, but very dangerous invertebrate creature, which occurs commonly throughout the south and south-east Pacific Ocean.

This potentially deadly animal is known as the blue-ringed octopus, and there appear to be two slightly different species, both conforming to the characteristics of the genus *Hapalochlaena.* In the more subtropical and temperate waters of the eastern coast of Australia, the blue-ringed octopus is known as *Hapalochlaena maculosa.* The lower latitudes with their tropical waters are inhabitated by a form known as *Hapalochlaena lunulata.* Its distribution seems to extend from the northwest coast of Australia throughout the Indo-Malayan Archipelago.

The blue-ringed octopus is a small cephalopod which rarely exceeds 20 cm in length, measured from the tip of one arm across the body to the tip of an opposing arm. Along the eastern coast of Australia, this species obtains a maximum weight of about 90 to 100 grams. However, the average mature animal seems to be rarely heavier than about 40 grams. At rest, this octopus is of a rather variable, often motley, brownish color, with more or less pronounced dark brown to ochre bands over the body and the arms. There are a series of faint blue, irregular circles superimposed upon these bands, hence "blue-ringed octopus." When the animal is being aggravated or disturbed, the colors darken rather dramatically, and the blue rings become iridescent peacock-blue.

The blue-ringed octopus is common in the shallow inshore waters around Australia. A study made by the Australian Commonwealth Serum Laboratories showed that this animal occurred at 20 different holiday resorts around Port Phillip Bay, Victoria. The Taronga Aquarium in Sydney received within one year 12 blue-ringed octopuses, collected at various local beaches. In view of such high population density of this dangerous creature,

the scarcity of reported bites from it is indeed surprising.

In its natural habitat, the blue-ringed octopus, essentially a nocturnal animal, seems to inhabit any of a number of hiding places, such as small caves, crevices, and under rocks. Empty beer cans and soda pop cans are favorite substitutes. This octopus is also seen rather frequently in clumps of cunjevoi (*Ascidia*), or sea squirts, along the eastern Australian coast line.

Like all other cephalopods, the blue-ringed octopus feeds on a variety of shrimps and crabs. Observations on captive specimens have shown two basic feeding patterns. If the animal had not been fed for some time and thus was hungry, a live crab offered as food was aggressively attacked. The octopus darted across the aquarium and descended upon the crab, biting it with its beak and attempting to restrain the crab with its arms. The octopus began feeding upon the crab once its movements had ceased and it had succumbed to the cephalopod's venom.

However, when an octopus in the experiments was well fed, it merely glided over to the crab, visibly squirted saliva into the water surrounding the prey, and then retreated a short distance away to watch and wait. Within a couple of minutes, the crab would go through a series of convulsions and become ataxic in its gait. Finally all movements would stop. When the crab was completely motionless, the octopus would approach again and begin feeding on it.

The greatly variable, often brilliant, colors of the blue-ringed octopus, together with its rather small size, make a proper identification rather difficult, especially since there are other very similar, but totally harmless octopus species in the same area. The bright blue rings seem to have a near magic attraction to people, who find this little octopus in shallow beach water. Human fatalities and near fatalities from blue-ringed octopus bites follow an almost repetitive pattern. Once the animal has been seen, it is invariably picked up and placed on the back of a hand or arm. It is then shown off to by-standers on the beach. The victim generally is unaware of the actual bite, but symptoms of intoxication occur within five to ten minutes after the animal has been handled. The symptoms commence with general weakness and numbness about the face and neck, combined with distinct breathing difficulties. From then on, there is a rather rapid progression to a state of flaccid paralysis and difficulty in breathing. Cardiac function remains unaltered until lack of oxygen becomes severe.

Octopuses in general have a unique mechanism with which to inflict puncture wounds. In species of the genus *Hapalochlaena,* this produces a path for the venom to enter the blood stream of the victim. A sharp beak is situated in the center of the common origin of the arms. An esophagus leads from the beak and the buccal mass into the body proper by passing through the center of the brain. Potent neurotoxins are secreted principally from rather large posterior salivary glands, which are located above the brain, a short distance away from the mouth. Single ducts from each gland join to form a common duct, which then passes downward through the brain, and finally opens into the buccal mass at the base of a tongue or radula. A special venom sac is not present. There appears to be a strong correlation between the size of these salivary glands – and thus the overall size of the octopus as such – and the difference between a fatal and a non-fatal bite. In other words, chances for survival of an unfortunate human victim depend upon the amount of venom injected by the bite of a blue-ringed octopus.

The toxin produced by this octopus seems to be the lowest molecular weight toxin that any creature has ever injected into man with fatal results. It consists of two major components, both individually fatal to experimental animals. Pharmacologically, the toxin affects both neuro-muscular junctions and nerve conductivity, inducing complete and rapid cessation of all voluntary muscle activity, including the diaphragm. Hence death is due purely to respiratory failure.

In recent years there have been at least three known reports of human fatalities, as well as several near fatalities, attributed to bites by the blue-ringed octopus on the Australian coast. With the Australians' affinity for a life on the beach, this octopus poses a serious threat to the unaware beachgoer. Consequently, the Australian Commonwealth Serum Laboratories have made considerable efforts to develop an antivenin for bites of this potentially dangerous animal. However, preliminary investigations suggest that this may prove to be quite difficult to accomplish, due to the inability of some of the toxic components in the venom of blue-ringed octopuses to produce antigens, the basic constitutents in an effective antivenin. Since the onset of paralysis in the unfortunate victim is extremely rapid, adequate and prolonged artificial respiration will – for the time being – remain the immediate and life-saving treatment for the bite of the blue-ringed octopus.

THE MOTH

G. Earl Chace

It has been over 300 million years since the first insects crawled out of the carboniferous swamps to start their long and varied existence. Since then, the class Insecta has risen to become a dominant portion of the animal kingdom. Whatever insects lack in size is more than compensated for by their 800,000 and more species and the billions upon billions of individuals.

As with all forms of life, in the course of development, insects tried many avenues. Their fitness for survival is proven by their moderate to phenomenal success in almost every instance. One failure, as proven by fossils, shows that they did try to increase their size, but the dragonflies with a 30-inch wingspan died out. Fossils also show that a few contemporary insects, such as the cockroach (Blattidae) and the silverfish (Thysanura), have remained virtually unchanged since those coal-forming days.

Today's insects are everywhere – in or on land, water, and air, and even in or on most of the animals and plants inhabiting those areas. Few of man's possessions, including his body, are not contested by insects.

Of them all, the order Lepidoptera, the moths and butterflies, has attracted the most attention. It has a world-wide distribution and some of its members are of considerable economic importance. Many are large and beautiful enough to be easily seen and readily captured. Indeed, most insect collections begin with Lepidoptera.

Considering the geologic age of insects, the moths and butterflies arrived late. They developed along with the flowering plants during the Tertiary period. Their name, Lepidoptera, denotes clear wings covered with tiny scales, and the order contains about 200,000 species.

The tiny flat wing-scales determine more than classification. They also give the clear wings their color and design. Scales vary in thickness, number of layers, striations, and roughness. Each variation refracts a different light and, hence, a different color. They are loosely attached and rub off easily, as collectors soon discover.

Although constructed of single strands of silk, the nest of the tent caterpillar colony is surprisingly durable. The insects return to it at night or during inclement weather; their exit and entrance hole can be seen in the center of the nest. Tent caterpillars are usually found on apple or cherry trees.

Lepidoptera is separated into suborders. The butterflies, suborder Rhopalocera, wear clubbed antennae; and the moths, suborder Heterocera, have plumed or feathered antennae. Butterflies are

diurnal and moths are generally nocturnal. Butterflies pupate in skin-like chrysalids and moths spin silken cocoons. Last, a butterfly at rest holds its wings together over the body, and a moth at its leisure flattens its wings out to the sides. All these differences have much variation and many exceptions.

Of the two suborders, the moths exact a far greater toll from agriculture. Every year some area is overrun with miller moths. They flock about our porch lights, collect on our windowsills, bang about our lamp shades, and shuck "miller dust," or wing scales, over everything. Annoying as this may be, the worst is yet to come. A miller is the common name for the adult army worm *(Cirphis unipuncta),* corn borer *(Pyrausta numbilalis),* tent caterpillar *(Malacosoma americana),* coddling moth *(Carpocapsa pomonella),* and many other agricultural pests.

I have seen an army worm invasion smother the fire of an oil-filled ditch, the survivors marching over the bodies of the vanguard insects to eat a whole field of standing oats. Army worms have completely enveloped buildings that stood in their way, packed the earth solid with their tiny marching feet, and created an ominous sound as they munched the grain.

I also have stood in a grove of oaks while gypsy moth caterpillars *(Porthetria dispar)* completely stripped the limbs bare. Their droppings on the dried leaves of the ground sounded similar to a hard hail storm.

Every road in America passes trees wearing the fresh or deserted silken nests of the tent caterpillar, or the fall webworm *(Hyphantria cunea).* In our homes, boxes of cereals sometimes disgorge small moths, whose larvae are still in the box eating the cereal. Clothes closets and chests are excellent places for other moths to lay their eggs, which will hatch into the tiny worms that chew holes in furs or woolens. Forests, parks, plains, meadows, backyards, and dwellings, all serve as home and furnish the food for at least one species of moth or its larva.

Some moths are relatively gigantic. The Atlas

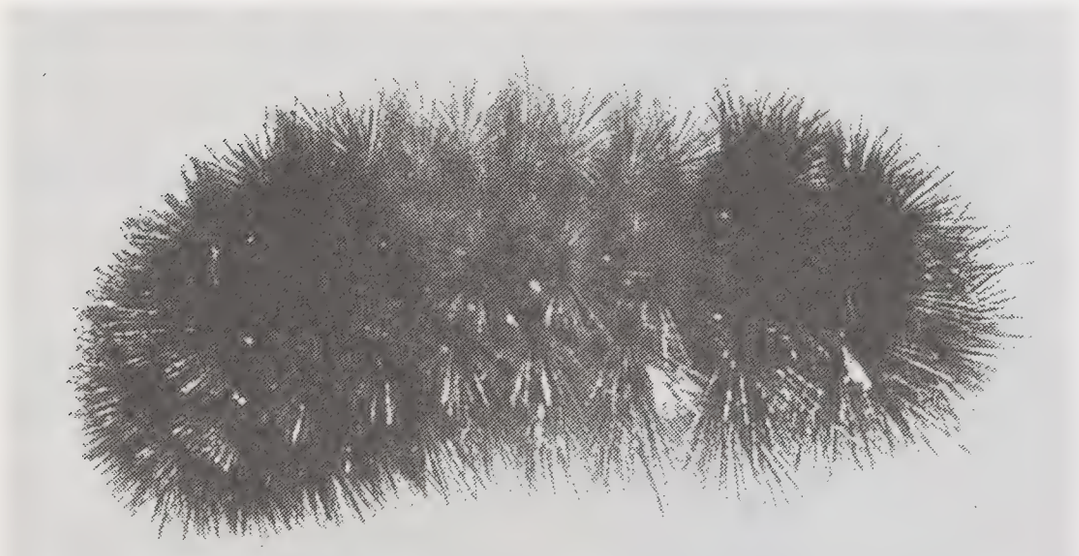
Shown at left is the cocoon of the *Samia cecropia* moth.

One worm is a seeming nonentity, but when joined by millions of its kind, the army worm is a respected devastating force. A full-grown worm is close to two-inches long. The one (shown above, left) is climbing up a crack in a shingle on the side of a house.

moth *(Attacus atlas)* of India has a ten-inch wingspan. Others are small. One group (the Tineoidae) has but a 0.12-inch wingspan and its larva spends its entire eating and growing period between the upper and lower layers of a leaf. Most midsummer leaves are insect-mutilated, but some have transparent, colorless blotches, lines, or circles on or in them. Some leaf miners, as these tiny moths are called, eat a wobbly trail that widens as the larva grows and ends in a blob. Because of its resemblance to a snake, such insects are known as the serpentine leaf miners.

Night-flying moths have adaptations for the nocturnal environment. Some species have eyes with mirror retinas that will reflect light just as a

The woolly bear caterpillar *(Isia isabella)* curls its body, presenting nothing but spines to a possible enemy. It is quite common throughout the United States. The adult moth is a small, orange colored "miller," speckled with black.

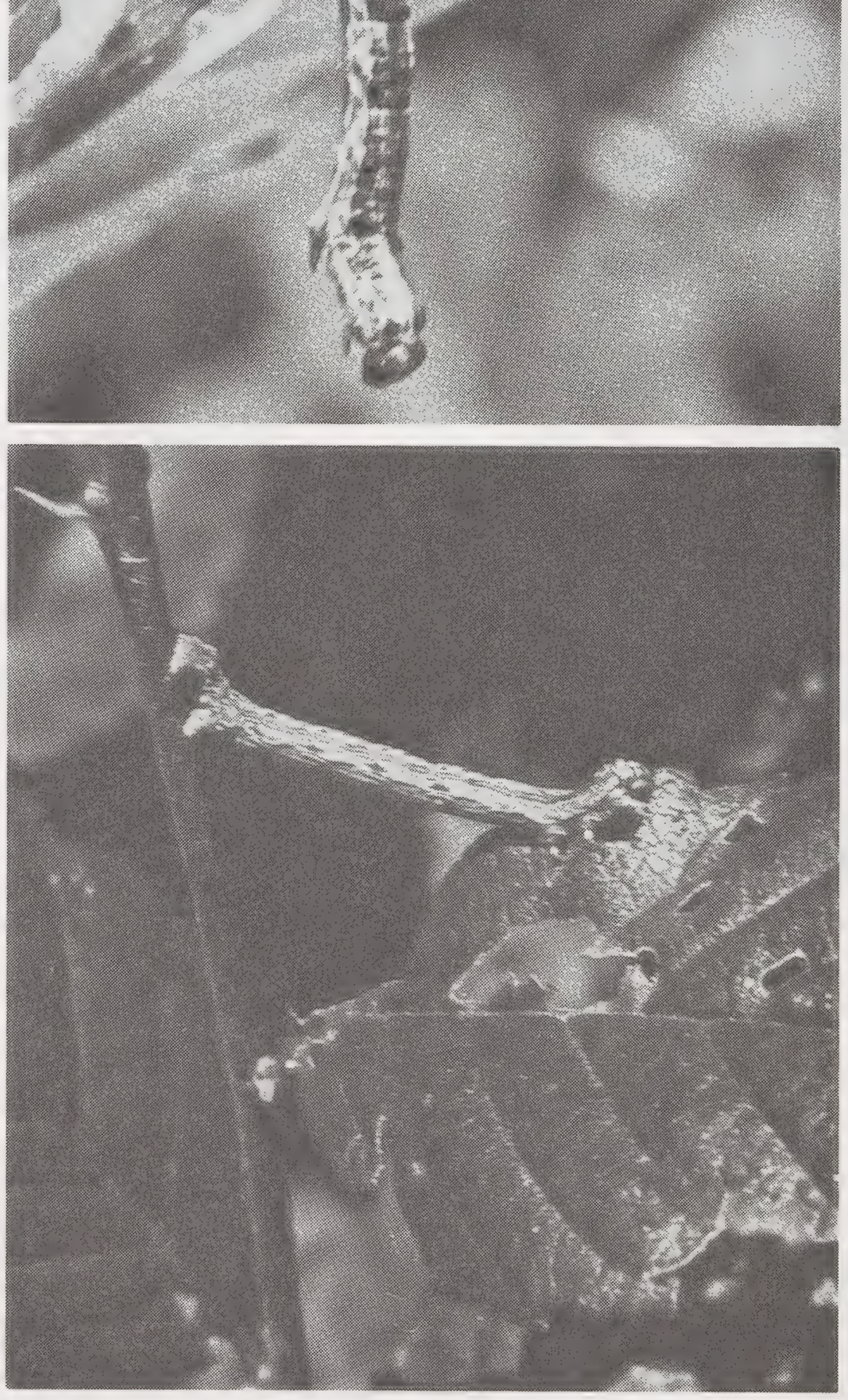


cat's eyes will. Many practice celestial navigation. The moon is so far away that by keeping it at an angle from but one eye, the moth can fly in a straight line. When an electric bulb or flame is substituted for the moon, its closeness forces the moth to circle it to maintain the same angle of flight. The circles get smaller and smaller until the moth reaches the light source. Collectors make use of this attraction to lights by shining a strong light on a white surface and netting the moths as they arrive.

Some moths have acute olfactory powers in their feathery antennae. Males of *Samia cecropia* can detect the scent of the females through a mile of confusing odors.

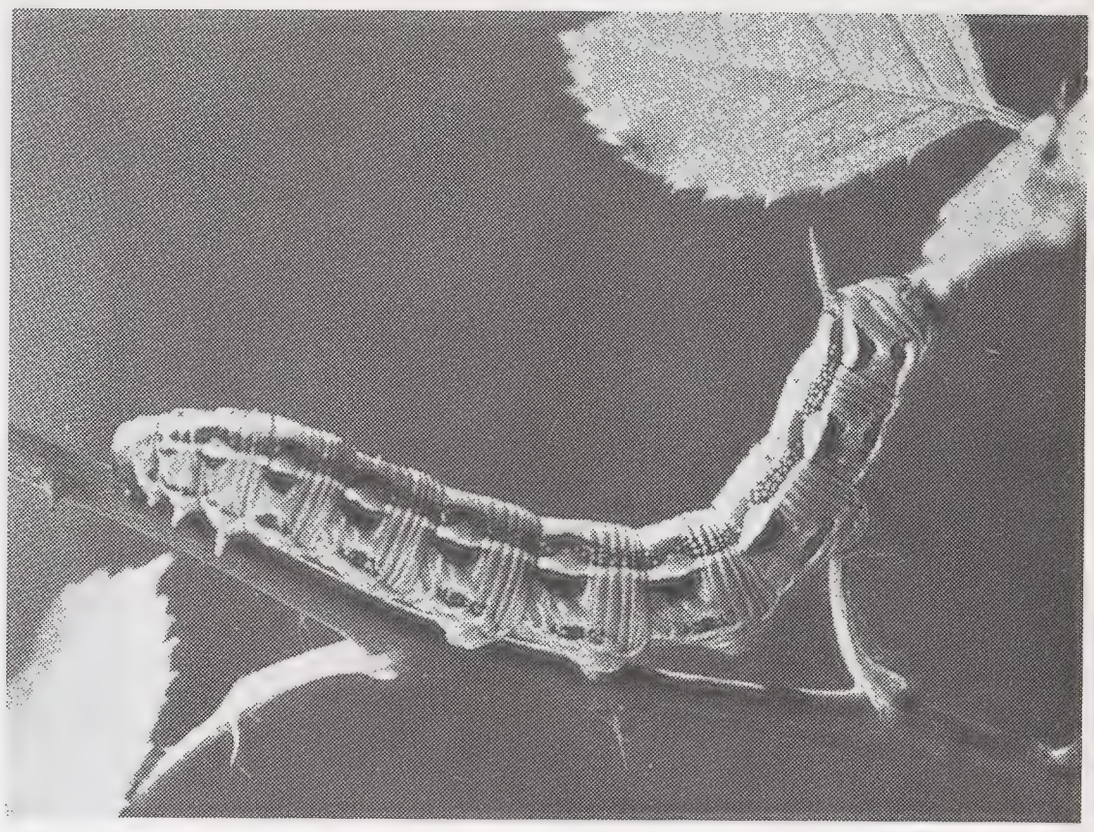
Few moths eat anything as adults, but some of those that do are attracted to sweet-smelling foods as nectar, which are located by the odor. Collectors will smear honey and water on the lighted white area to attract these moths.

Shown at right is the male Indian luna moth, *Actias selene.*



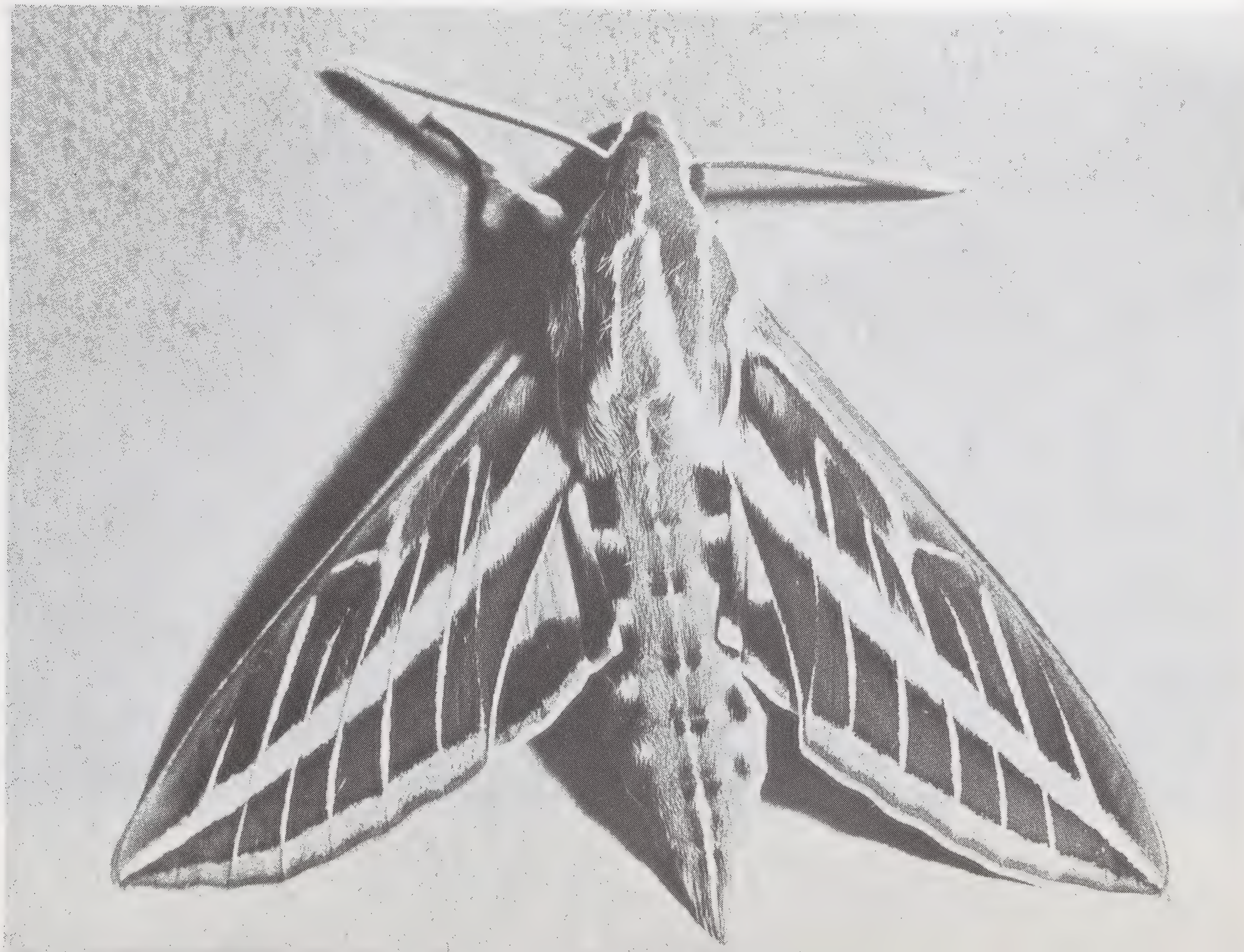
Whether called measuring worms, inch-worms, or just plain geometrid larvae, these caterpillars (shown above, top and bottom) have legs on either end, none in the middle, and walk with a looping gait. For defense, they stiffen their bodies and look just like dead twigs.

Many moths never eat, some have even lost their mouth parts, but those that do live long enough to need sustenance gain it by sucking nectar from flowers. Their stomach is the pump that sucks the sweets through a long hollow tongue. When not in use, the tongue is carefully coiled up under the owner's mouth. Above, the tongue of a sphinx moth is shown partially coiled.

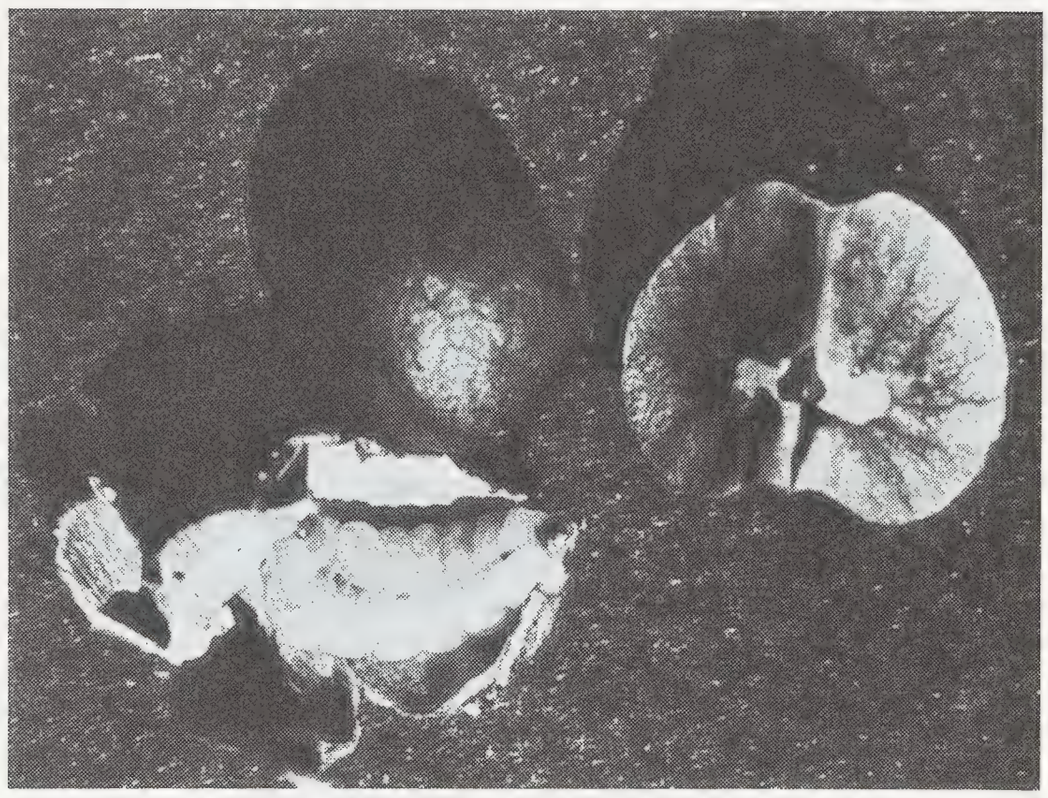


Although known as a portulaca eater, this three-inch larva of the striped sphinx moth is crawling on a climbing rose. Actually, it is almost a general feeder. There is another color phase of this caterpillar wherein the body is black and the spots yellow. The anal horn is indicative of the family Sphingidae.

The striped sphinx moth *(Deilephila lineata)* in build resembles a fighter plane, but it is far more maneuverable. Sphinx or hawk moths can hover in front of a flower and allow the long uncoiled tongue to probe for nectar. The actions and the sound of the wing beats gave it the name hummingbird moth.



An oak leaf becomes a dwelling and food larder for the tiny *Nepticula* larva which has eaten out its home from the inner layers of the leaf. Because of the shape of its home, it is called a serpentine leaf miner. The adult moth grows to have a .12-inch wingspan.

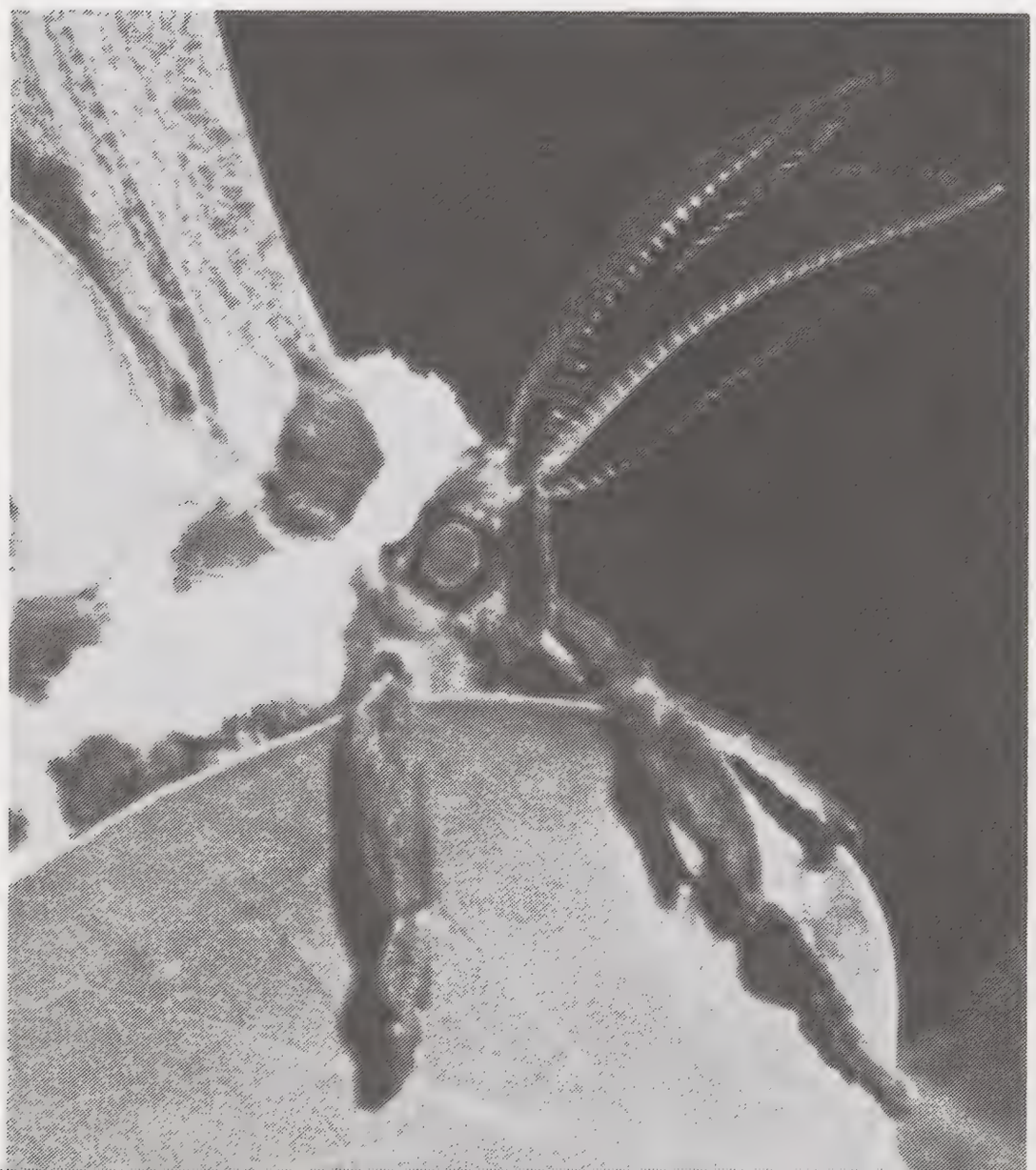


Split open an active Mexican jumping bean and you will find the *Carpocapsa saltitans* worm. This moth larva is activated by warmth, and it is the larva changing positions that motivates the bean.

A pair of *Samia cecropia* moths are shown engaged in mating while clinging to one of their many food plants, in this case a lilac bush.

A "bag" made by the larva of *Thyridopteryx ephemerafornia,* or bagworm, serves as shelter and nursery. The female moths are visited inside by the males. After mating and laying eggs in the bag, the female dies, plugging up the exit hole with her body. The bags are made by gluing bits of the food plant together.

This photograph of one of a pair of breeding *Cecropia* moths is enlarged to show its light-reflective eye and plumose antennae.



Moths have enemies – in summertime, the bat and the bird. Every street or porch light attracts its quota of misdirected moths, and diving silently right through the milling throng may come a wide-mouthed, hungry bat. Just before the sky becomes dark enough for the bats to leave their "belfrys" and caves, the early-flying moths become the target of swift-flying nighthawks and whip-poor-wills. Should the moth seek safety on the ground or in the trees and shrubs, it may become prey for frogs, toads, or lizards.

Even before the moth becomes a moth, its larval or caterpillar-like stage is a fair target for many species of birds, amphibians, reptiles, and carnivorous insects. Some beetles of the Carabidae have become such persistent predators of caterpillars that they have won the common names of caterpillar hunter and searcher.

The *Cotacla* moth blends in with a tree-bark background. The lower wing was eased open to show why these moths are also called underwings.

Moths have some protection against enemies. Almost perfect camouflage protects many as they rest during the day. The underwing moths *(Catocala)* spend the day resting on the bark of a tree. Their forewings cover the body and so closely resemble the bark it is extremely hard to find them. When they fly at night and are protected by the dark, they expose their hind or underwings which are striped with red, orange, or black bands.

Night-flyers depend upon either sight or sensory hairs that alert them at the slightest change of air pressure or movement. Bats and birds must set up alerting currents on the approached side, and the moth takes the appropriate evasive course.

Caterpillars and worms also use camouflage. The tomato worm *(Protoparce quinquemaculata)* is as green as the leaves it eats. Harris' sphinx moth larva *(Lapara bombycoides)* is alternatingly striped with green and white lines that perfectly match a group of pine needles where it lives and upon which it feeds.

Many worms live within the food plant, such as the corn borer and the leaf miners. Others, as the larva of *Automeris io,* are covered by poisonous spines. A few, as the hickory horned devil *(Citheronia regalis),* use size and appearance for protection. This caterpillar reaches four inches or more in length, the diameter of a thumb, and wears half-inch-long, curved spines on its back. It makes one wonder how such a fearsome looking caterpillar can eventually become the beautiful regal moth.

Looking close at the opened cocoon of a hawk moth, one can see the outline of the wings, veins and all.

Attitude protects some caterpillars. The yellow-necked caterpillar *(Datana ministra)* will almost come to attention when disturbed. It feeds in groups on apple leaves, and each individual will rear both ends as if to strike. The inch worm larvae (Geometrids) will hang on the branch with their hind end and stiffen their bodies out until they exactly resemble a dead twig. A few will also glue bits of food to their backs for camouflage.

Scattered through the insect world are many parasites. Ichneumon flies, braconid wasps, and others, large and small, live by placing their eggs on, and often in, another insect. When hatched, the young parasites eat their way in or out, killing the host. The moth family is bothered by parasites all the way from egg to adult.

Parasitized larva do not die at once. The parasite seems to know how much of what to eat without destroying the host until it, the parasite, is ready to pupate. Frequently, a large caterpillar will be found with a group of tiny cocoons standing on its back. These are braconid wasp cocoons which soon will open, releasing adult wasps while the host collapses.

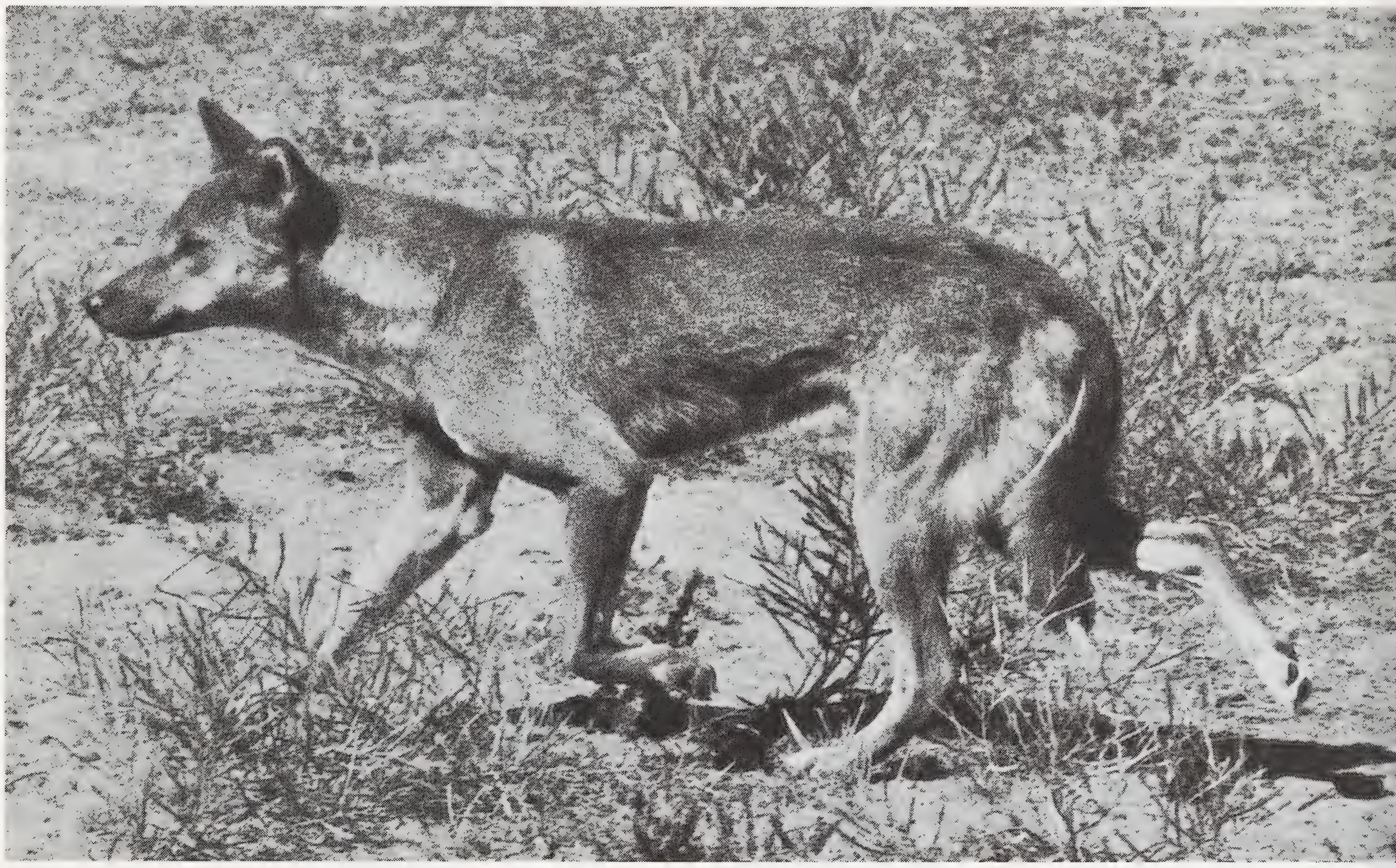
The moths are subjected to yet other natural but lethal enemies. Bacteria and fungus seek out all stages of a moth's life, and when possible, invade and destroy.

Being prolific, moths survive. Some females will lay 700 or more eggs per season. Others produce several generations per summer.

Although some types of moths cost us money or ruin our dispositions – as the coddling moth does when its larva becomes that "half a worm" in a bite from an apple – many of them are welcome. The silkworm *(Bonbyx mori)* has provided ladies with silk cloths, fishermen with fly ties, and doctors with sutures for years. The yucca moth *(Pronuba yuccasella)* sustains the yucca plants by fertilizing its flowers. The Mexican jumping bean would not jump if the little larva *(Carpocapsa saltitans)* were not in it. The Atlas, luna, polyphemus, regal, and hundreds of other moths lend beauty to the world. All moths contribute considerably to the great food chain which, if broken, could cost us our existence.

There is no escaping the moth. Whether you are a silk merchant making money, a collector enjoying its beauty, a farmer fighting its depredations, a consumer paying higher food prices because of what the moth larva has eaten, or merely a taxpayer helping to defray the cost of control, you are involved.

DINGO *Wild Dog of Australia*



by Edward Ashpole

The dingo is a tall, rangy animal, with prick ears, a somewhat bushy tail, and coarse hair, usually yellowish-brown in color.

The dingoes at the Arid Zone Research Institute at Alice Springs, Australia, are fine looking dogs. "I think the Australian wild dog is an intelligent animal," says Laurie Corbett who is group leader at Alice Springs in the CSIRO* dingo research program. "And if they're bred in captivity, or hand-reared from young pups, they're very affectionate dogs," he said, as friendly dingoes leapt up to greet us.

As a pet, however, the dingo has drawbacks. Corbett once kept as many as 15 dingoes in his apartment at Alice Springs to get them used to handling for the research program. "But the neighbors complained," he said. Tame dingoes will chew up anything about the house capable of being chewed. And they will often help themselves to the neighbor's chickens – and probably his cat too.

But attractive though the dingo is, the wild dingo is one of the biggest wildlife problems in Australia. Six biologists and eight scientific assistants have been engaged in the CSIRO dingo program which was begun in 1966. Their aim is a comprehensive knowledge of the ecology of the dingo. Such knowledge is badly needed in Australia because, at present, no one really knows the full extent of the damage done by dingoes, and no one knows how they can be effectively controlled.

A lot of money has been spent and is being

**Commonwealth Scientific and Industrial Research Organization.*

spent on ineffective measures to control the dingo, ineffective because the dingo population is as large and active as ever it was. Every Australian state, except Tasmania, which has no dingoes, spends many thousands of dollars annually on the administration of Dingo Destruction Boards and on bounties for dead dingoes. New South Wales and South Australia each pay a six dollar bounty. The Victorian bounty is four-and-one-half dollars. Western Australia and the Northern Territory each pay two dollars. These differences in bounty rates only lead to some smuggling of dead dingoes from state to state.

Corbett is against the present system of dingo control. "If you want to ensure that an animal maintains its numbers, the best way is to put a bounty on its head. Trappers will then make sure that its numbers are maintained. I don't think any animal has yet been effectively controlled in this way." By "effectively controlled," Corbett of course does not mean "exterminated." Australians want to keep their dingo, but under control.

The dingo is being studied mainly in the cattle country of the Northern Territory, in an area of 10,000 square miles in the Alice Springs region. There the environment is simpler and the dingoes more numerous. They may also be purer stock, less contaminated by domestic dogs. Over a thousand dingoes have been caught there since the program started four years ago, providing information on diet, numbers and distribution, breeding, and population structure.

The techniques and knowledge gained in the Alice Springs area will be applied later in the eastern sheep areas of Australia where the dingo can be a serious problem. "Sheep being smaller are more susceptible to attacks than cattle," says Corbett. "Not all dogs attach sheep, but those that do have probably in some way acquired a taste for sheep and do considerable damage." In eastern areas the dingo's natural food includes wombat and wallaby. To a dingo, a sheep may not be all that different from these two animals.

"We want to understand the life-cycle of the dingo," continues Corbett. "Because once we know this, we should be able to see how to develop effective control measures that affect the dingo at its weakest link, as most animals have a weak link somewhere in their life-cycle."

The main loss to the cattle industry in the Northern Territory is damage to meat rather than calves killed. No reliable figure yet exists on the loss being sustained, but, according to an estimate by a large meat works in the Northern Territory, three percent of meat is downgraded or rejected because of dingo bites. If this applies to all meat works, the Northern Territory alone suffers a million-dollar-a-year loss.

Corbett and his colleagues have shown that calves are sometimes killed by dingoes for food, although in the Alice Springs region dingoes normally eat rabbits, rodents, and lizards. "In semi-drought stricken areas natural food gets in short supply and the dogs tend to pack," he says. "We've found that their diet then includes cattle carcasses, and sometimes fresh calf."

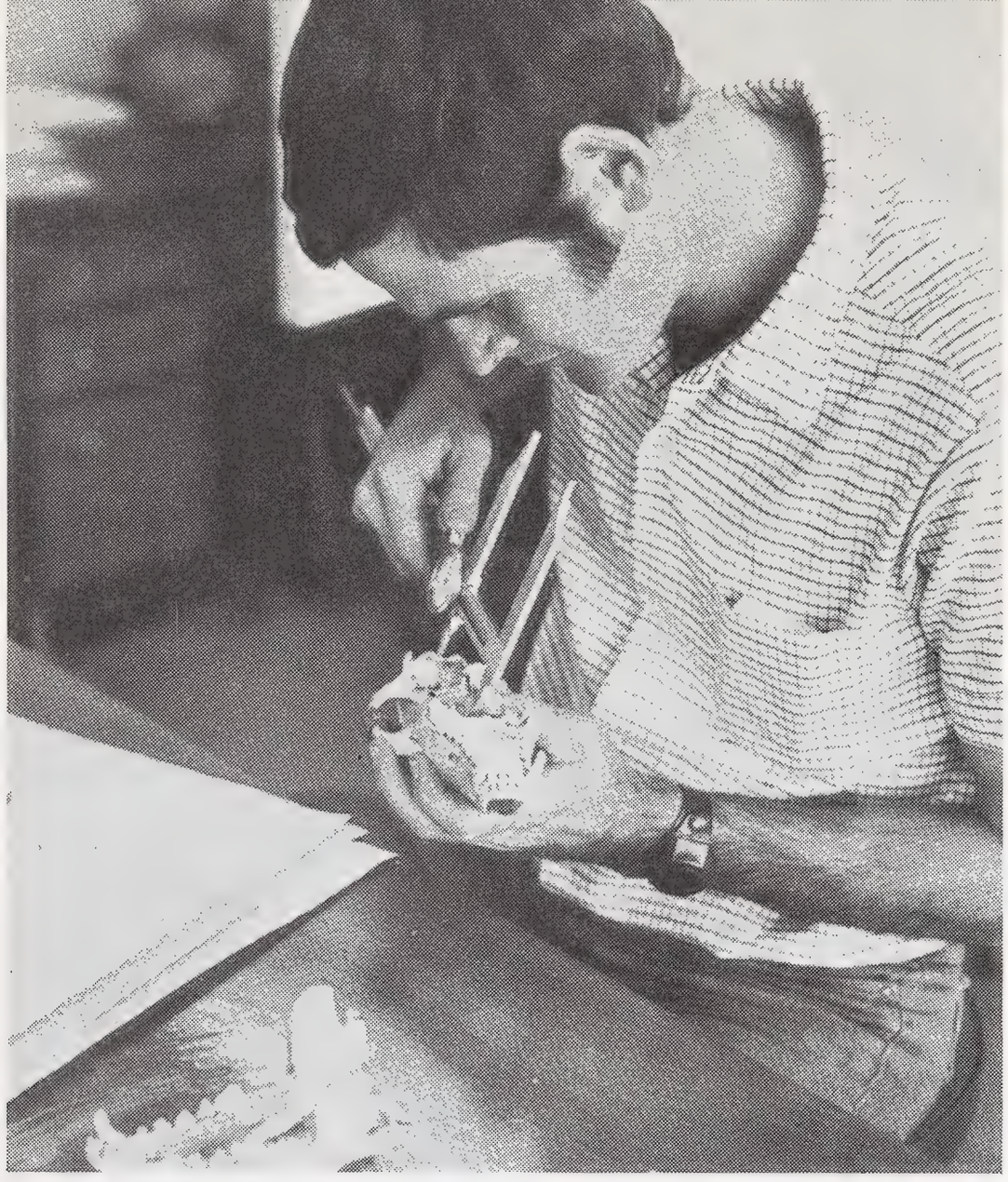
Corbett's observations of dingo behavior have led him to a theory that most of the calves killed by dingoes are not killed for food but because of the dingo's dominance behavior patterns. A dominant dingo stops or modifies its attack when faced with the submissive behavior of another dingo, which includes the lowering of head and tail and the flattening of ears.

Corbett points out that in the wild, calves do get knocked down by playful dingoes. The dingo then expects the calf to display the appropriate submissive behavior. Instead the calf gets up and tries to run away. The dingo then automatically attacks and either badly wounds or, more usually, kills the calf through the wounds it inflicts.

Another of Corbett's theories is that many young dingoes learn how to hunt from adult males and not from their mothers. The mother weans the young dingoes at two to three months of age and leaves them by a water hole. There they attach themselves to adult males coming in to drink. "We often see adult males with pups, and by imitating the actions of the adult they may learn how to hunt for themselves," Corbett says.

When the dingo came to Australia, no one knows for certain. But it could not have evolved independently on the isolated continent of Australia; its resemblance to the normal domestic dog is much too close. According to recent research, the evolution of the dog family started with the ancestor of the Indian wolf; dogs followed behind man and evolved on all continents except Australia. The dingo is related closely to the present-day Indian wolf and the New Guinea dog, and it now appears certain that it was brought to Australia by the ancestor of the aborigines more than 3,000 years ago. This is the age of the oldest genuinely dated dingo remains.

Dingoes, unlike domestic dogs, do not reach sexual maturity until their second year. They do not bark, although they howl with considerable power. Dingoes are usually ginger-brown in color,



A member of the CSIRO research team measures a dingo skull; measurements enable the true dingos to be distinguished from crossbreeds.

but there are striking variations, such as black-and-tan and whitish brown. "People have thought that the color variations were the result of crosses with domestic dogs, but I think most of them are real dingoes," says Corbett. "In the laboratory we've compared certain blood characteristics and skull measurements of dingoes, crossbreeds, and domestic dogs. We've found that each of these groups is distinct, and that many of the black-and-tan dingoes have the same blood proteins as the more usual ginger dingo."

The dingo's reproduction, water physiology, and biological scents are all subjects of advanced laboratory study at Alice Springs and the headquarters of the CSIRO Wildlife Division in Canberra. Nowadays, wildlife research is a close combination of modern laboratory techniques and field work which often uses advanced technology. Corbett and his colleagues will shortly be using an infra-red viewing system to watch dingoes at night, instead of having to rely on the full moon.

"This is the first major scientific study of the dingo," says Corbett, "and we're confident that with our resources and techniques we will succeed in finding ways of controlling the dingo. We don't want to wipe it out, of course, because the dingo is part of our national heritage. We just want to be able to keep the dingo in its ecological niche where its numbers will remain within an acceptable limit."

animal kingdom REPORTS

A NEW OUTLOOK FOR AMBOSELI

The following is a special report on the New York Zoological Society's effort to aid the Government of Kenya to preserve the Amboseli Reserve as a national park. Dr. David Western is a leading ecologist in African studies and a professor at the University of Nairobi in Kenya.

A solution to the land-use conflict that has centered on the Amboseli basin for the last two decades could prove to be a milestone in a number of respects. To the conservationist, the most significant is understandably the wider measure of protection it will afford to one of the most remarkable wildlife populations in the world. To Kenya, its importance lies more in the increased production of the land it secures, while in terms of resource management it offers a cogent example of the validity of land-use planning. But to fully appreciate these points, one must consider the present use of the area, the uniqueness of the ecosystem, a history of its development, and the background to the present solution.

Background to the Present Proposals

The background work for the present proposals began at the end of 1967 with broad-based ecological study of the Amboseli ecosystem. Its objectives were to determine the structure, use, and changes of the area, an imposing task with the limited finance and manpower available. The most important results in the initial stages were simply an inventory of population figures and their utilization of the area. Since then the results have gone far beyond this, in showing how far different species are dependent on the basin, and how the Masai ecology fits into the ecosystem, and most important, in providing an insight into the past and probable future changes in Amboseli. The outcome is that Amboseli is now one of our best comprehended wildlife systems.

It is obviously of paramount importance that in a developing country such as Kenya the best use of its limited natural resources be made. This means that of the development strategies possible in any land-unit, that which is most productive locally and nationally is understandably in Kenya's best interest. It was this approach which formed the basis of the present proposals. The range of possible uses that Amboseli could be put to, within the limits of capital and technology available, were evaluated. A cost-benefit analysis was then made for each: that is, the returns accruing from a unit of land balanced against costs economically, ecologically, and socially. Livestock ranching, which is the most feasible form of agriculture, was evidently, even at maximum production, unlikely to yield over one-third of the present returns of wildlife through tourism. Within the basin, wildlife usage was clearly by far the most profitable exploitation for both the Masai District Council and Kenya as a whole. Outside the basin, except for seasonal movements, game numbers are low and are unlikely to be as profitable a usage as livestock.

Game Sanctuaries vs. Livestock

Optimal forms of land-use were suggested in the form of a proposal for the development of Amboseli to full park status, with primary consideration given to livestock development in adjacent rangelands. The wet season ranges of wildlife would overlap with Masai interests, but unless thousands of Masai were displaced at an impossible cost, economically and politically, this was un-

avoidable. Moreover the wet season areas were too ephemeral to provide good tourist viewing. To overcome this problem, it is proposed to institute a system of compensation to the Masai for utilization of parts of their rangelands by the Amboseli wildlife. The overall profits accruing from Amboseli Park will in this event prove a viable and extremely profitable solution for both the Masai and Kenya, while protecting the unique ecosystem of Amboseli.

The Use of the Area

Masai Amboseli Game Reserve covers 1,259 square miles of southern Kenya, immediately below Kilimanjaro. Most of the reserve is sparsely populated by both wildlife and Masai pastoralists, reflecting the limited distribution of permanent water. However, the base of Kilimanjaro differs from the surrounding dry bush country in being the dessicated remnants of an ancient soda lake, forming a low-lying trough, the Amboseli basin. Much of the mountain's northern catchment discharges its cold, fresh water into the basin, where numerous springs well-up to sustain an impressive area of swamps. Providing one of the few permanent water sources in the area, it serves as the dry season epicenter of enormous wildlife and livestock populations, despite the comparatively impoverished pastures. During the rains when the constraint of water is removed, most of these populations move to the more attractive pastures elsewhere.

The ancient lake gradually became colonized by vegetation following its dessication, the successive plant communities progressively moving toward the basin center from the original lake shores. Since a small area still forms a seasonal lake, much of the succession can be traced from here to the shoreline. The result is an amazing variety of habitats within the small area to be established as a park, ranging from the peripheral dry bush and lava flows, through savannah woodlands, groundwater forest, swamps, seasonal lakes, open plains, and bare exposed lake floor. Such a range of habitats accounts for the unique concentration and diversity of Amboseli's wildlife, over 70 species of large mammals within the 150-square-mile park boundaries. There are in addition over 400 bird species from lilytrotters to semi-desert species. Wildlife is extraordinarily tame from long contact with the non-hunting Masai, while the area is one of especially attractive scenery, set off by the impressive colossus of Kilimanjaro. It is this unusual combination of attributes that set it aside as one of the most impressive of Africa's landscapes.

A herd of Masai cattle are shown above in an over-grazed area near Lake Amboseli. In the future, hopefully such dry arid conditions will be avoided by a land-use program that will benefit both the people and the wildlife of the area.

The Changing Role of the Masai

The Masai have over the centuries gravitated toward Amboseli in the dry season for the same reasons as wildlife. The Masai's system of pastoralism is highly specialized and efficient in an environment where modern livestock-ranching is unlikely to improve their production substantially. Their ecology is geared to mobility and ensures the exposure of livestock to the most suitable grazing areas, which continually change with the seasons and usage. In this manner the Masai compete directly with wildlife populations, which their herds replace to a great extent. But there are many regulating factors limiting their own system, so that throughout Masailand wildlife populations have thrived and largely continue to do so. The Masai's inadvertent conservation of wildlife, today a valuable asset to Kenya, has in the past largely worked against their interests most obviously in their displacement from the richer parts of their range to meet the rigid demands of conservationists.

Much of the traditional role of pastoralists is changing, largely becasue of their increasing receptiveness to modern technology, and with it their

aspirations. The people's complete dependence on the ecosystem has been severed through medicine, water development, trading, and famine relief in extreme situations. Most are concerned to acquire legal title to their present rangelands as a guarantee against exploitation from other interests. The repercussions on wildlife are variable, but still fairly subdued. Fencing has commenced in some areas, but it does not affect game movements around Amboseli, and is unlikely to do so in the future. Overstocking is a major problem, though again, the impact on Amboseli is not so crucial. Perhaps the two most conspicuous problems in Amboseli are the increasing level of poaching by a relatively few individuals and the general hardening of attitudes of local Masai to wildlife, since wildlife conservation threatens to displace their interests. Tsavo West, Nairobi National Park, Serengeti, and in part Ngorongoro provide poignant examples in which the Masai lost excellent land, with little or no compensation, in the interests of wildlife.

Past Conservation Efforts

Conservation efforts affecting Amboseli are not new. The entire District of Kajiado, including Amboseli, was contained within the Ukamba Game Reserve, established in 1899, later to become the Southern Reserve. Amboseli National Reserve was established in 1967, so that at least on paper, hunting has been prohibited for the last 70 years. It was little visited until the 1950s, after which progressive pressures were exerted to afford it full national park status. All efforts failed in view of the existing occupancy and land rights of the Masai.

In 1961 the administration of Amboseli was transferred to Masai Kajiado County Council, so that for the first time revenues from the area directly benefitted the Masai. However, efforts to establish a national park redoubled, particularly in response to the worldwide publicity that the area was being degraded to a dust-bowl through the action of livestock overgrazing. Well-intentioned plans were proposed, none of which made much headway. Characteristic of all these proposals was the fact that there was no empirical information on the ecosystem, particularly movement patterns. Neither was there much incentive for the compliance of the Masai, who stood to lose substantial revenues from a resource returning most of their district income.

The misguided approach of later proposals was unfortunate and did much to congeal the attitudes of the Masai against proposals which would in any case have been disastrous for both Amboseli and the Masai. It did, however, provide a breathing space in which to re-evaluate the whole issue from a practical standpoint. This was essentially an ecological approach, considering the land-use problem through resource management principles.

Consideration of the Masai aspirations is therefore directly the responsibility not only of the Kenya Government but, in its own long-term interests, of Amboseli too. Amboseli as a park could not survive in its present form without depending on the surrounding areas and, therefore, Masai grazing-grounds. North of Amboseli the provision of water will provide better grazing-grounds than those the Masai will relinquish in Amboseli. At the end of the dry season, they preferentially graze the northern grasslands, most of which however are beyond traveling distance from the basin's permanent water supply. In the southern basin the situation is different. Here the Masai, due to the poor grasslands of the lava-strewn plateau, have always depended heavily on the swamps. Part of their intransigence in the past toward any plans for a park was due to their correct assertion that water supplies alone would not compensate them for the deprivation of the swamps in Amboseli. The present proposals suggested redirecting part of the swamp system further south, outside the proposed park boundaries, to compensate for the loss of vital grazing.

The present proposals were drawn up and submitted to the Kenya Government in 1969. These formed the basis of a Presidential Decree issued in July 1970 setting aside 150 square miles of Amboseli as a government-administered national park. Water development for the Masai was accepted as a related and complementary development, with revenues from Amboseli going both to the previous Masai administration and government. Boundaries for the park were surveyed and demarcated in December 1971, and an official notice declaring Amboseli a formal park is soon to follow.

The cost of water development for the Masai is considerable, and the Kenya Government requested the New York Zoological Society, in view of its past interests in Amboseli, to assist the proposals over and above the figure of $150,000 already allocated for the project. Water development proposals had at this stage already been drawn up, to which the Masai had agreed. In conjunction with representatives of the New York Zoological Society, it was possible to improve on

the development plans, subject to further funds becoming available.

With the implementation of the Amboseli proposals, the future of a unique and spectacular ecosystem will be largely secured. But more important is the precedent it establishes. At a time when the developing countries in particular are facing a people/resource crisis, we have reached the point where an integrated land-use approach must necessarily supplant the unilateral approach to conservation. Amboseli has gone a long way to show the guidelines. Pending the outcome of a reasonable solution, other district administrations are contemplating establishing their own game sanctuaries. If in a solution to Amboseli, it is shown that a realistic outcome for varied interests involved is possible, conservation will more rapidly establish priorities in similar situations in the future.

David Western

EDITOR AND CURATOR APPOINTED

Simon Dresner has been appointed Editor and Curator of Publications and Public Relations for the New York Zoological Society. He will be the editor of the society's popular magazine, *Animal Kingdom,* and its scientific journal, *Zoologica.* He will also coordinate the public relations activities for the Bronx Zoo, New York Aquarium, Osborn Laboratories of Marine Sciences, and Center for Field Biology and Conservation, which are operated by the society.

Mr. Dresner is an established science writer and editor, and is a member of the National Association of Science Writers. He was managing editor of *Science World,* an educational science magazine, and was also editor of an industrial environmental newsletter. He has written and produced audio-visual materials and is the author of several books on popular science, mathematics, and American history.

He has wide experience in scientific and technical public relations in the environmental field. Mr. Dresner received a B.A. in mathematics from the University of Michigan in 1956. A native New Yorker, he now lives in Mahwah, New Jersey, with his wife and two children.

ABOUT THE AUTHORS

Edward Ashpole is an Englishman who has written on Australia. **G. Earl Chace** is Curator of the Black Hills Reptile Gardens in Rapid City, South Dakota. **U. Erich Friese** is Curator of Fishes at the Taronga Zoological Gardens Aquarium in Sydney, Australia. **Dietrich Schaaf** is a scientist with the Department of Fisheries and Wildlife at Michigan State University, who has studied African elephants in the wild.

ILLUSTRATION CREDITS

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dying species...

"The beauty and genius of a work of art may be reconceived though its first material expression be destroyed; a vanished harmony may yet again inspire the composer; but when the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can be again."

William Beebe
First curator of birds, Bronx Zoo

SCHAUS' SWALLOWTAIL
Papilio aristodemus ponceanus
Schaus

Insects are everywhere – 1,250,000 of them. During their 300 million year existence, the six-legged arthropods have evolved in many directions and have become adapted for life into almost every imaginable habitat, from the frigid arctic and antarctic regions to the harsh desert environs. They have been discovered living at altitudes up to 20,000 feet and deep within the earth's crust in subterranean caverns. Some are capable of reproducing in pools of petroleum around oil wells in California, while others successfully occupy hot springs where temperatures may reach 125 degrees.

Although the vast majority of insects are less than one-quarter-inch in length, as a group they display an enormous range in size. The smallest – scarcely 1/100th of an inch – are smaller than some single-celled protozoans, while others reach a length of over eight inches. One of the winged insects, the Atlas moth of India, bears wings which can measure 12 inches from tip to tip.

During the building boom of the late 1950s and 1960s Americans began to witness personally the accelerated disappearance of species from the environment. The sacrifice of land for a multitude of home sites and highways and the increased usage of pesticides stilled the voices of their birds and left their gardens a little less colorful. Like the birds, the disappearance of the butterflies could not go unnoticed. The monarch, red admiral, great spangled fritillary, and the swallowtails were reduced in numbers.

Of the known vanishing butterflies, one of the most endangered forms is Schaus' swallowtail. First discovered by Dr. William Schaus in May 1898, in Miami's Brickell Hammock, the south Floridian subspecies of this Antillean form has led a roller-coaster career in its struggle for existence. Following its discovery, only one additional specimen was recorded from the Miami area. Lepidopterists who came in search of it found its habitat destroyed by the city's growth. Although believed to be extinct, the search for the butterfly continued, and in May 1935 it was rediscovered on Lower Matecumbe Key. In September, four months after its rediscovery, the Florida Keys were struck by a hurricane which was particularly devastating to Matecumbe. Once again, *Papilio aristodemus ponceanus* was believed extinct.

Several years later, the yellow-marked chestnut wings of Schaus' swallowtail were observed in hardwood hammocks elsewhere in the Keys. During the early 1940s, the rare *Papilio* gradually increased in numbers. Unfortunately, the news of its survival spread. Each May and June, when the four-inch swallowtails were emerging from their pupal cases, collectors were there to exploit them. It is reputed that a pair of the rare butterflies sold for $150. As expected, their numbers rapidly dwindled. The years that followed brought land clearing and pesticides. Yet somehow they managed to hold on and survive.

Today, *P. a. ponceanus* faces a crisis from which it cannot survive unaided. The torchwood and wildlime, trees upon which the larval swallowtails feed, are being rapidly eliminated as man destroys the last of Upper Key Largo and Lower Matecumbe Key's hardwood hammocks. Schaus' swallowtail occurs nowhere else in the world.

It is doubtful that a handful of concerned lepidopterists can generate enough sympathy among Florida's legislators to halt construction activities. Perhaps, as a last resort, a small colony of the butterflies will be transplanted into the Everglades National Park. This idea is not new; it was attempted some years ago. Although initially successful, the budding population was eliminated by a hurricane from this region of its former range.

The outlook for this butterfly's survival appears dim. Unfortunately, it is not unique, for many other fascinating insects have joined Schaus' swallowtail in a futile struggle for survival. Their disappearance from the complex web of life may be overlooked by man, but many forms which have developed a close interdependancy with the vanishing species suffer greatly and may also be destroyed. No one knows how many or which of the world's 2,000,000 plants and animals are essential to man's continued existence. One thing is certain, it is foolish to continue the wanton sacrifice of additional wildlife species.

JOHN L. BEHLER

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THE WORLD OF BIRDS

A SPECIAL ISSUE OF **ANIMAL KINGDOM**
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JUNE 1972

The Old and the New at the Bronx Zoo

Contrasting scenes from the old Bird House and the New World of Birds

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The Lila Acheson Wallace World of Birds

A New Experience in Environmental Education

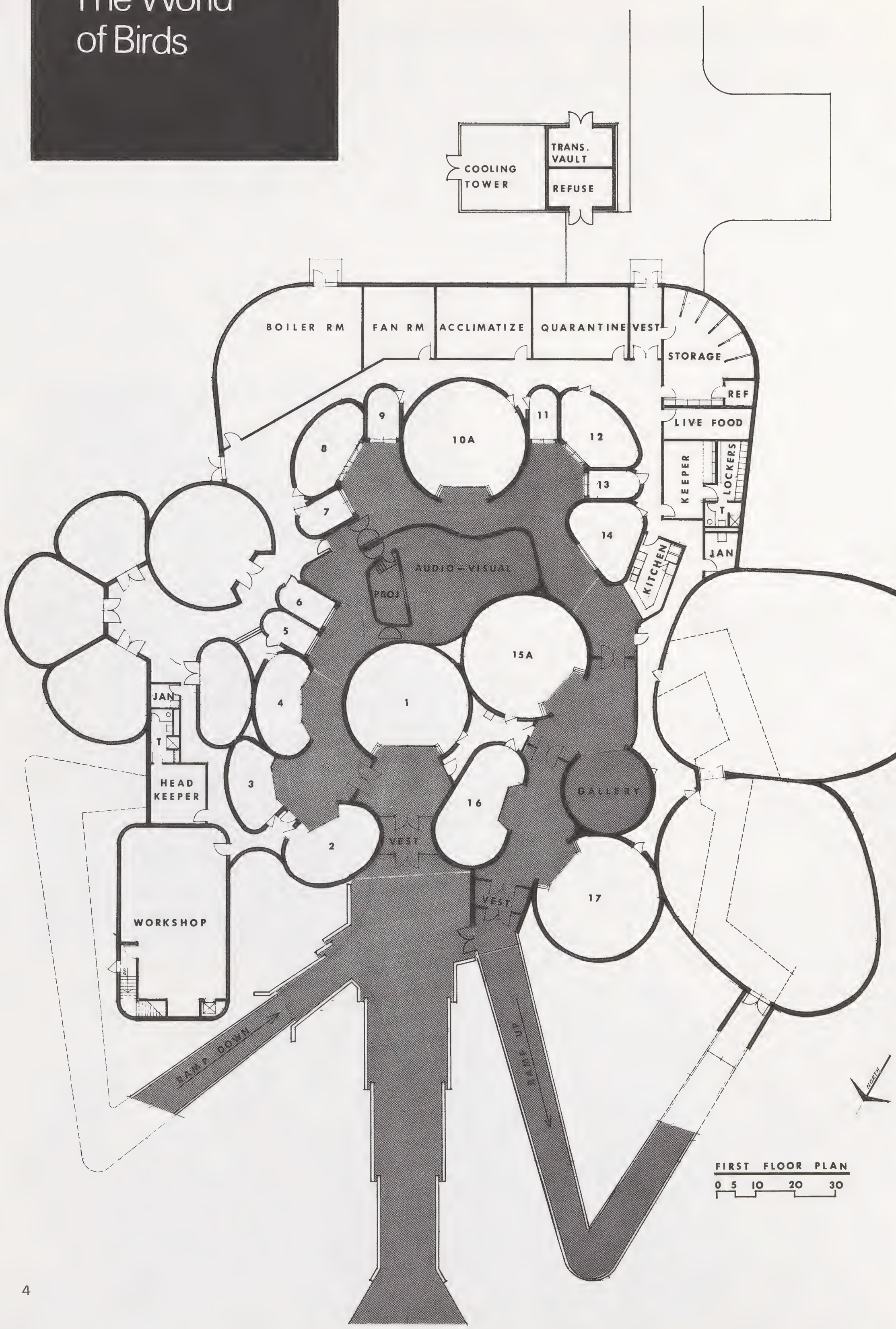
Birds are among the most conspicuous and best loved of all wild creatures. From desert to swamp, mountain lake to tropical lagoon, almost no habitat is without the grace and beauty of birds. Their soaring flight, dazzling colors and incessant activity have fascinated man from time immemorial. Birds have inspired poets, on one hand and confounded engineers on the other. Among the first of man's primitive cave wall scratchings are representations of birds and today more people study birds than all other kinds of wild animals put together, laymen as well as scientists. Amateur ornithologists are legion and their societies may be found throughout the globe. It is fitting, therefore, that the most ambitious and imaginative attempt at exhibiting wildlife ever undertaken at the Bronx Zoo should be the Lila Acheson Wallace World of Birds.

This exciting new exhibit building has been constructed through the support of Lila Acheson Wallace and typifies her deep interest in the natural world. By making the World of Birds possible, Mrs. Wallace has brought the magic of this world closer to all who visit it.

Lila Acheson Wallace

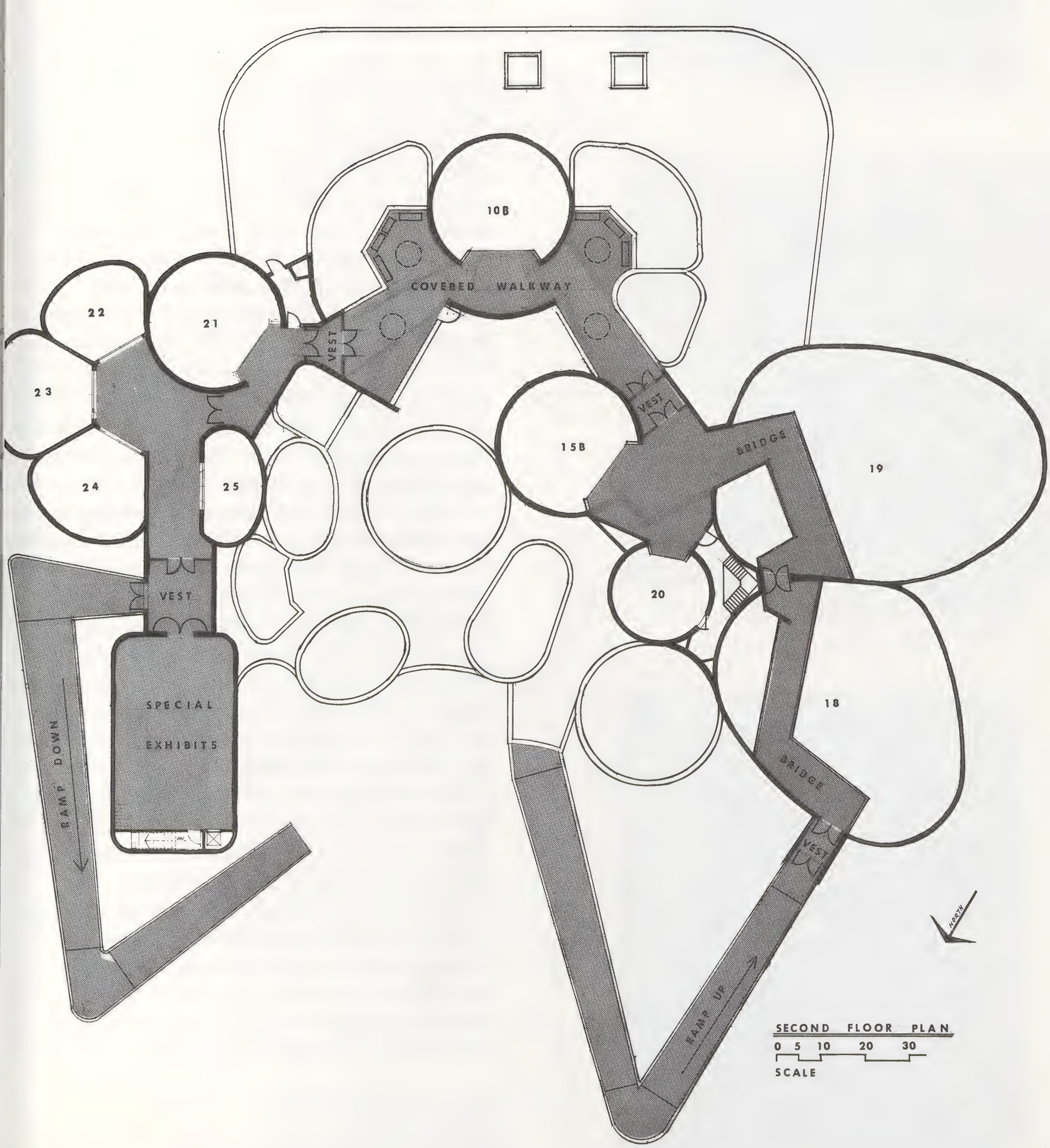
The World of Birds building, with its sweeping shapes, conveys a sense of drama and excitement.

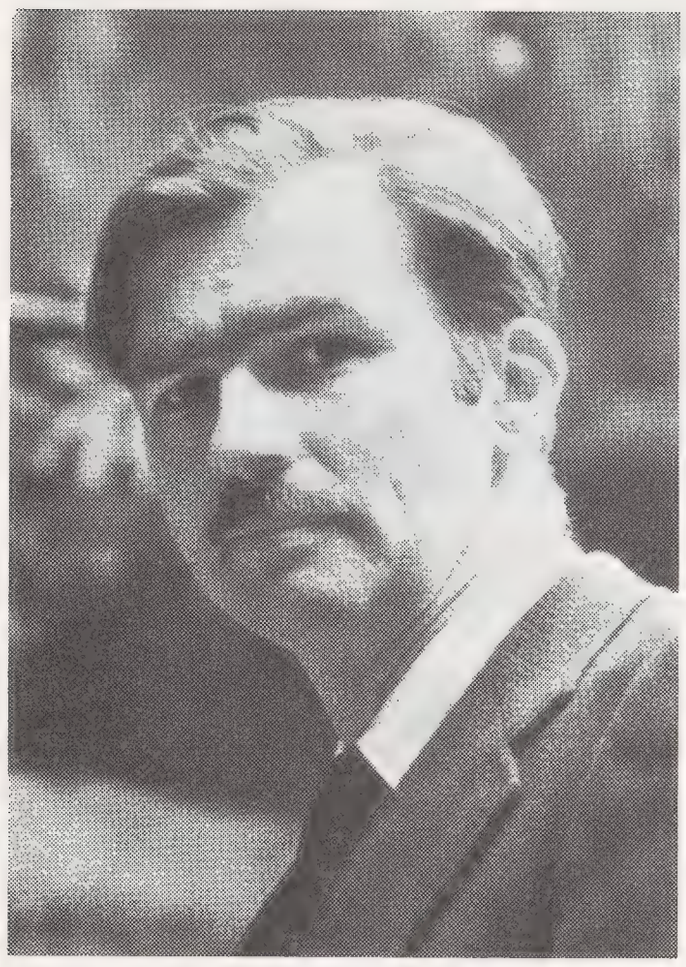
Exhibit Plan - The World of Birds



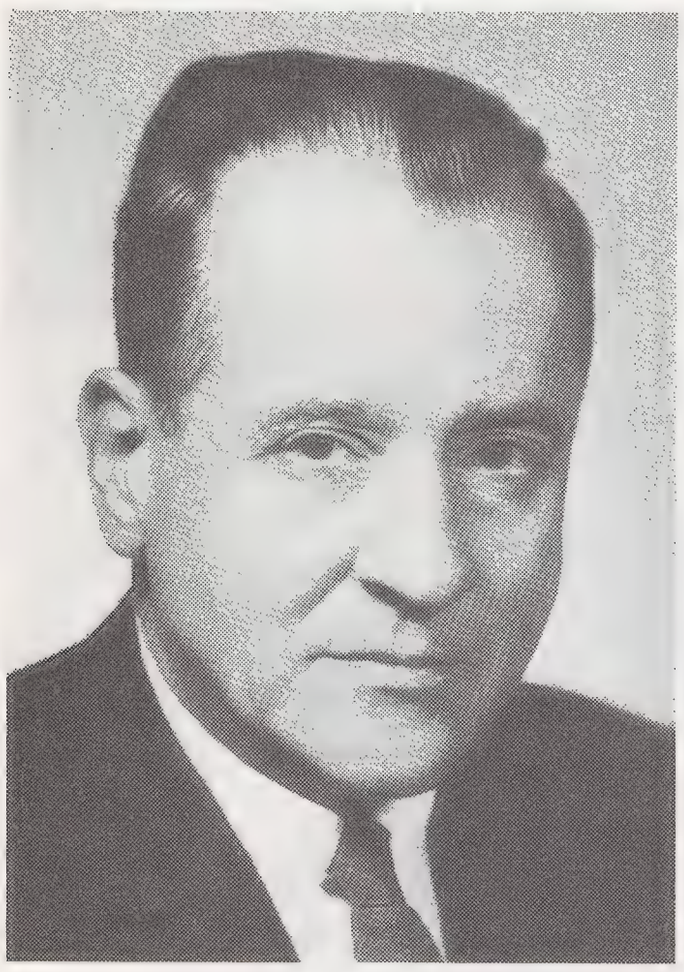
LEGEND OF EXHIBITS

Secrets of the World of Birds	**2-6**
The Mating Instinct	**7-9**
The Bird and its Nest	**10-14**
Birds Around the World	**15-20**
The Treetops	**21-25**





William G. Conway



Morris Ketchum, Jr.

Jerry M. Johnson

Design and Development - a team effort

The organization and concepts of the World of Birds are the work of William Conway, general director and curator of ornithology for the New York Zoological Society. With architects Morris Ketchum, Jr., and Associates (also designers for the zoo's World of Darkness), superintendent of operations Charles Driscoll, curator of exhibition Jerry Johnson and ornithology curators Joseph Bell and Donald Bruning, Mr. Conway led a team effort which has raised the exhibition of living creatures and the place of zoos in environmental education to a new level. Many of the displays are highly experimental but, encouraged throughout by Lila Acheson Wallace, the design team has not side-stepped the challenges of attempting new approaches and techniques. The building was constructed by the William Crow Construction Company. The exhibits were prepared by the members of several zoological society departments: exhibition, ornithology, construction and maintenance, and gardening.

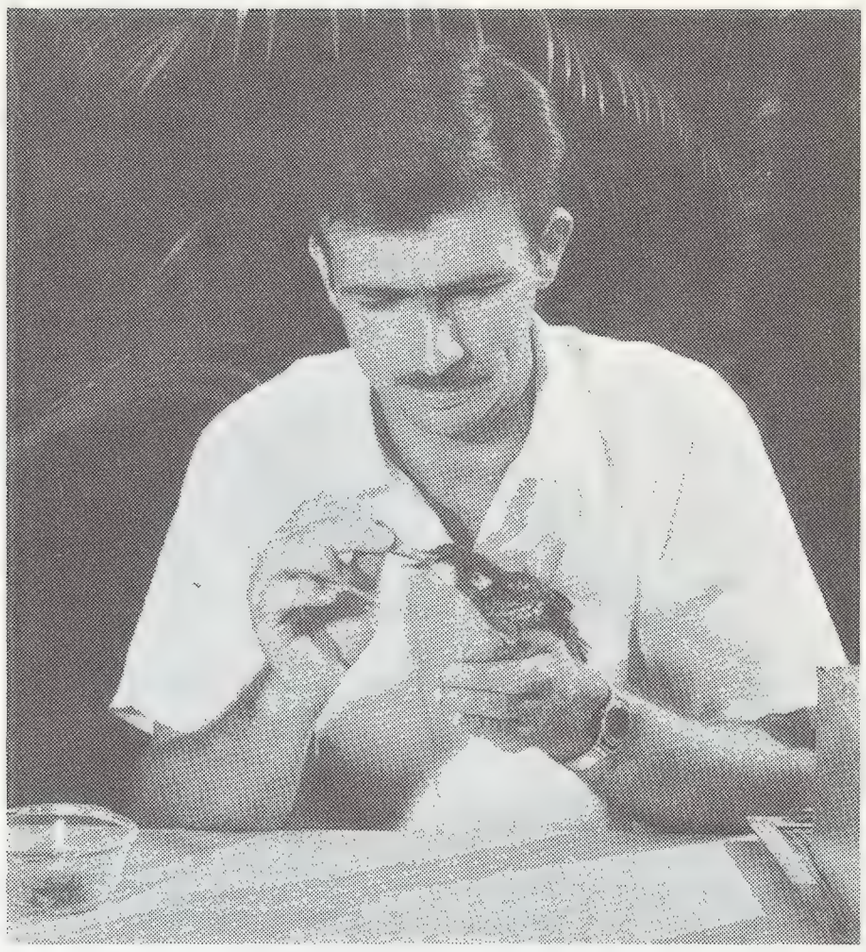
The architects not only have been responsive to new exhibit concepts but creative in incorporating them within a functional building; a structure which carries its visitors from sloping hillsides to wooded swamps, from Australian scrub to New England forest and from jungle floor to tree-top vistas. Several exhibits are seen at more than one level. Yet the viewer enters the building, passes through it and returns to his starting point without ever having to backtrack or climb a flight of stairs.

The World of Birds is a planned introduction to wild birds. The concept has been to exhibit birds better, more beautifully and more meaningfully not simply to house a larger collection.

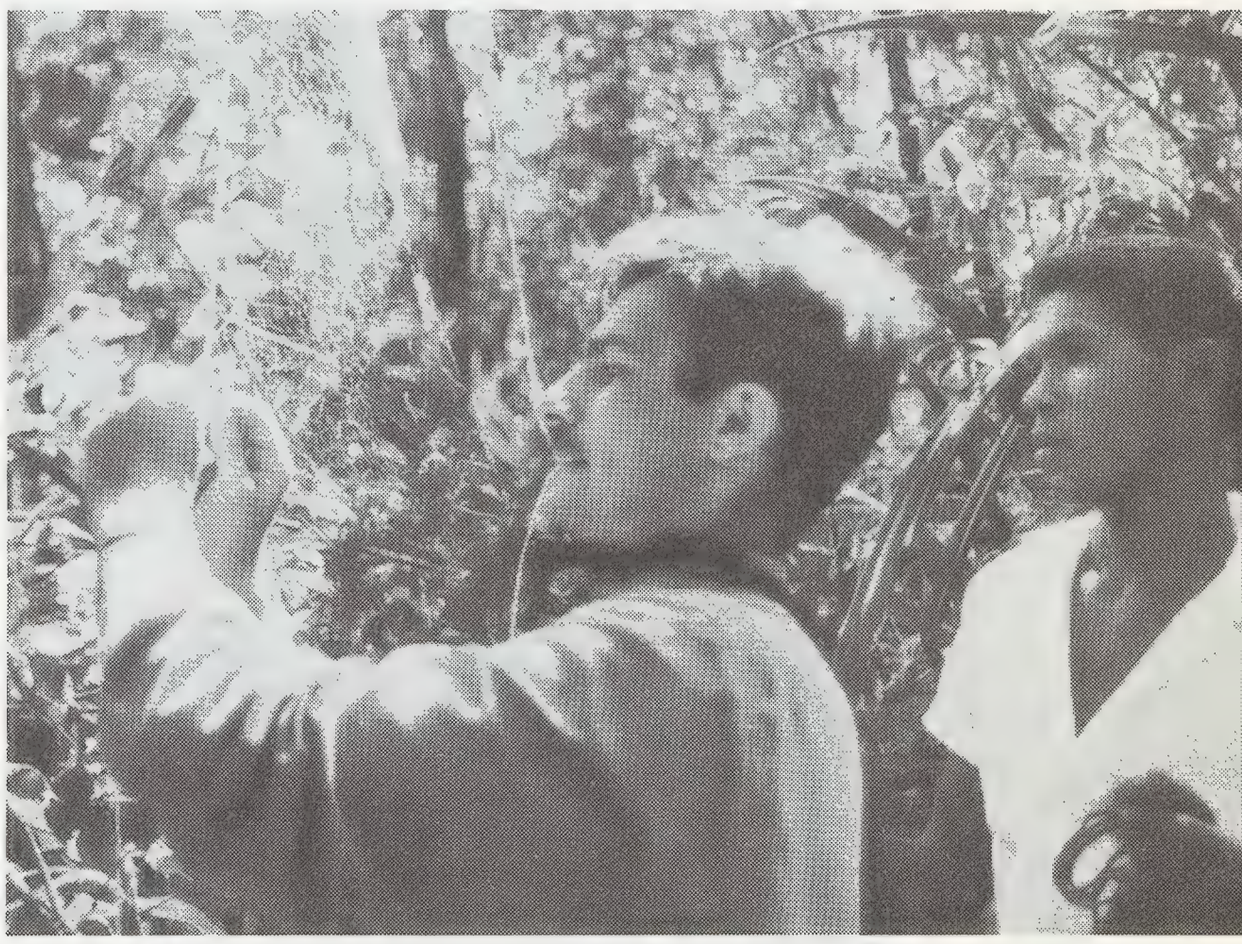
For the many visitors who has no familiarity with birds beyond city pigeons, starlings and sparrows, the World of Birds can awaken a new excitement and concern with the natural world. For all New Yorkers, the World of Birds offers a new dimension in environmental education.

Robert G. Goelet
President
New York Zoological Society

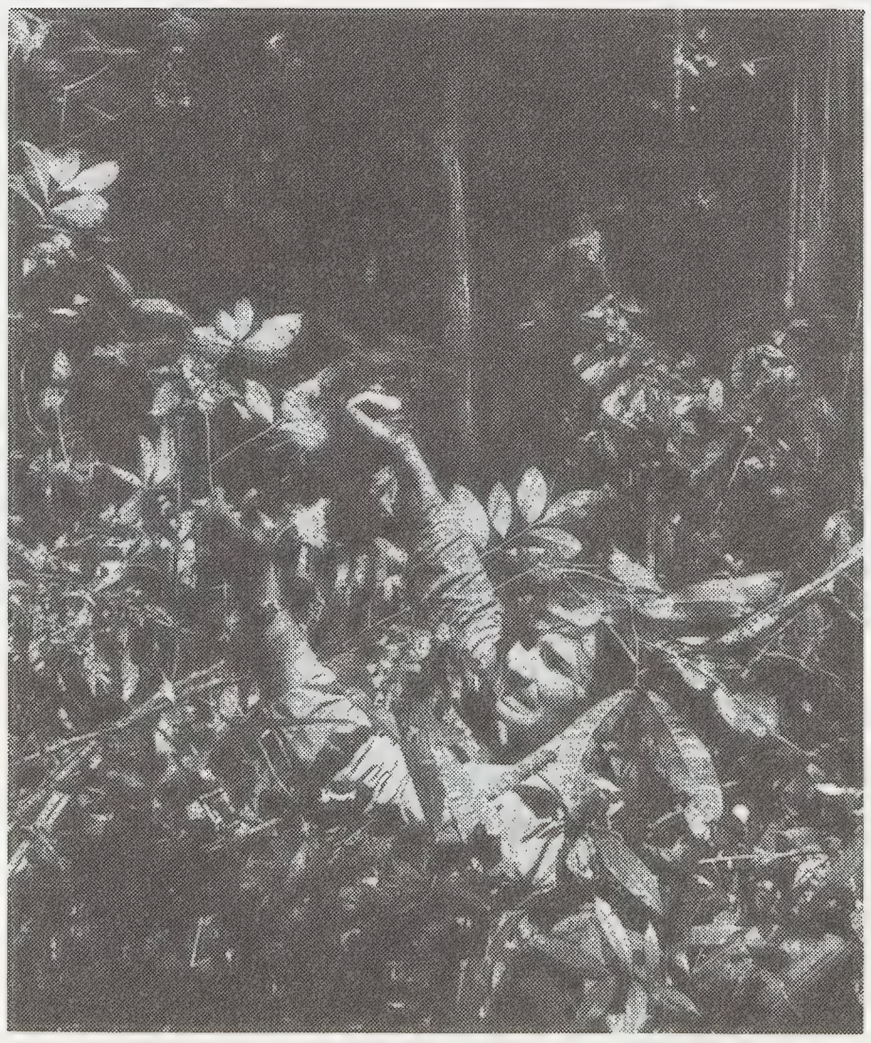
Our Birds -
how we get them, how we care for them.



A variety of nets and snares are used in collection of birds. Once caught, a bird destined for a zoo collection is babied to the point of being fed by hand, if necessary.



Birds come to zoo collections in a number of ways. Some birds are hatched in the zoo. Zoo professionals are trying to make captive breeding the number one source of rarer birds. At present, however, many birds still must be collected in the wild. A few expert collectors, scattered around the world, are used by most major zoos. Once in a while, if a very special bird is needed, a zoo may send out its own expedition to collect it. Zoo birds are under constant watch of keepers, curators and veterinarians. The Bronx Zoo's staff has developed dozens of special diets which are substitutes for food birds get in the wild. An insectivorous bird, for example, gets a zoo diet rich in protein. Hummingbirds are fed a nectar substitute. Toucans eat chunks of fruit and small animals in the wild, so their zoo diet is lumpy. Flycatchers feed on small insects. In the zoo their food is fine grained. Fortified with vitamins and minerals, zoo diets often are more nutritious than the real thing.



Collecting just the right bird for a zoo exhibit often sends a zoo man scrambling high in the treetops.

Simulating the World of the Wild

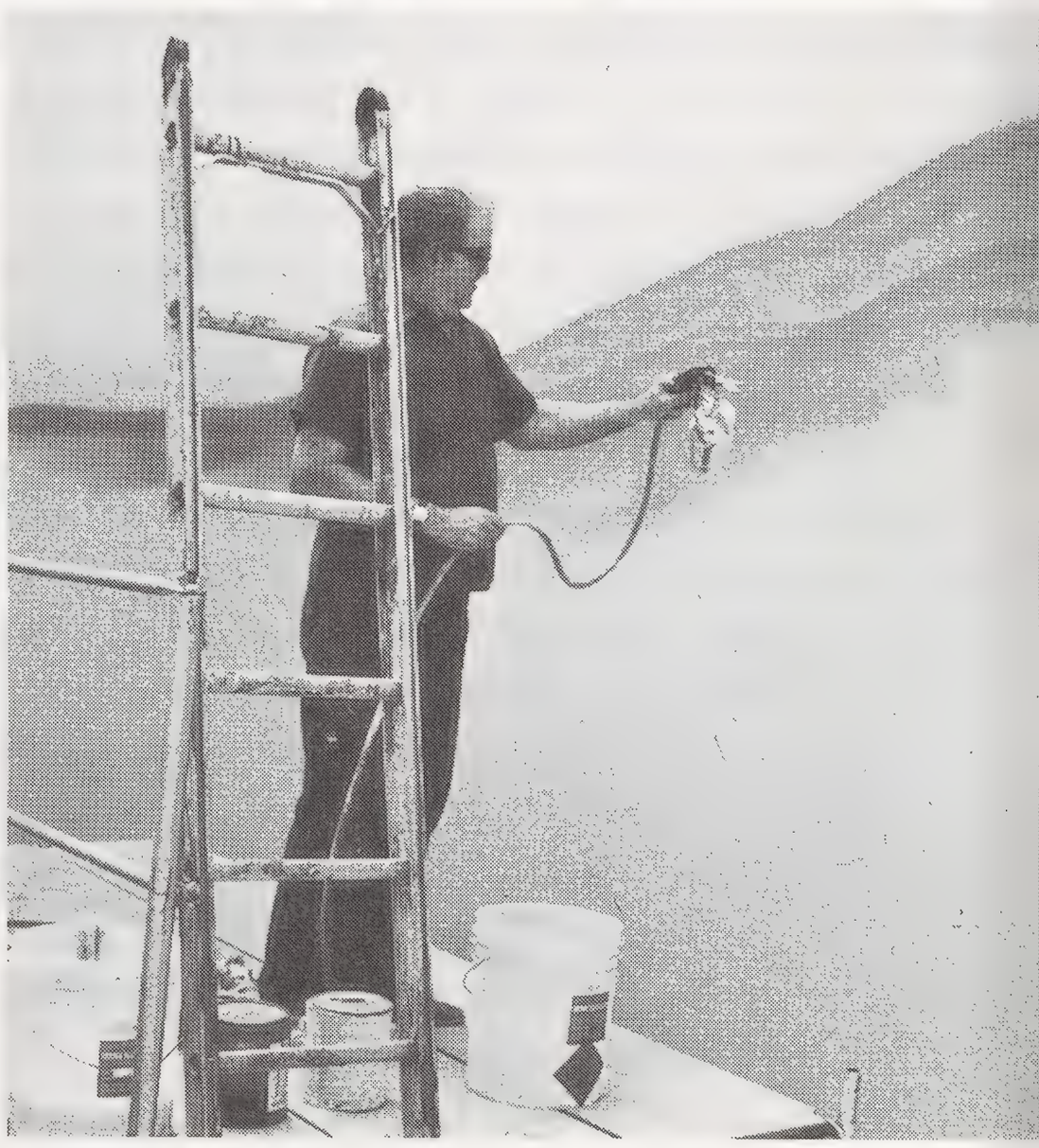
The Preparation of Exhibits

Exhibit crews create "rocks" out of fiber glass over a structural framework.

One of the most difficult tasks in operation of a zoological park is to develop exhibits that suggest the wilderness habitat of an animal, and yet are practical to maintain and easily viewable by the public. The exhibits in the World of Birds began years before as ideas in the minds of zoo staff members. The planning and execution of the exhibits required the combined talents of zoologists, designers, artists and technicians —— specialists with skills ranging from sketching animals to spraying concrete.

Years before the opening date exhibition crews were at work casting rock faces on the Hudson Palisades of New Jersey so that realistic moulds

Bird keepers and gardeners carried in trees and stumps for the exhibits.



A background landscape of forested hills begins to take shape on the wall of an exhibit in the World of Birds. Creation of a zoo exhibit requires artistic talents as well as knowledge of animals and their habitats.

After the massive cliffs of the rain forest exhibit were constructed, crews stained the artificial rockwork to enhance its natural appearance.

Cypress trees, noted for their resistance to deterioration, are installed in a swamp exhibit.

Rich, black earth is poured into a cranny in artificial rockwork so that zoo gardeners may plant living vegetation in this World of Birds exhibit.

could be made for the artificial work in the cliffs of the World of Birds' New World Rain Forest. The size of the cliffs, which tower up to 50 feet in the air, required a new approach to construction of artificial rock. A special method of construction combining the use of glass fiber rocks and sprayed concrete was developed specifically for the cliff project.

Months before the opening of the World of Birds crews were laboring building cliffs and waterfalls, planting live trees and shrubs, and painting landscapes.

In the end, the natural world of birds was recreated within the walls of a sophisticated new structure that has set the pace of zoo exhibition for years to come.

Window on the Wild

A toucan, noted for its gaudy bill, perches at visitor-eye level in a treetop exhibit.

A South American ant pitta, which dwells primarily on the ground, shares the Dance of the Manakins exhibit with the manakins, birds that perform dazzling acrobatics during courtship display.

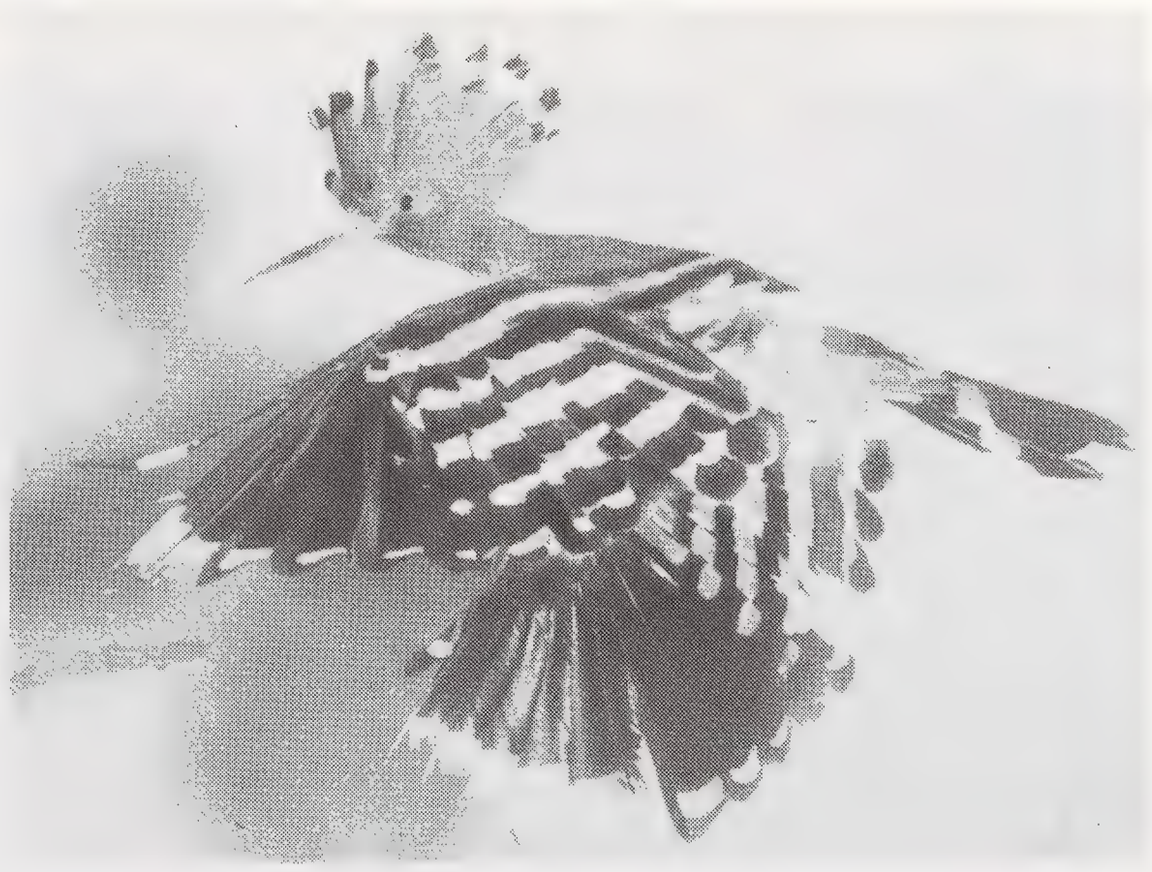
Grenadier waxbills perch in the scrub growth and shrubs of the arid scrubland exhibit. The birds are African.

Many of the exhibits in the World of Birds offer wide panoramas. Here, visitors can view life in the treetops.

A tiny hemipode, one of the smallest of ground-dwelling birds, blends with the sandy landscape of the arid scrubland.

Adaptations for Flight

Soaring, as demonstrated by a turkey vulture, is one of the simplest types of flight. Soaring birds take advantage of air currents, such as the thermals produced by warm air as it rises from the ground.

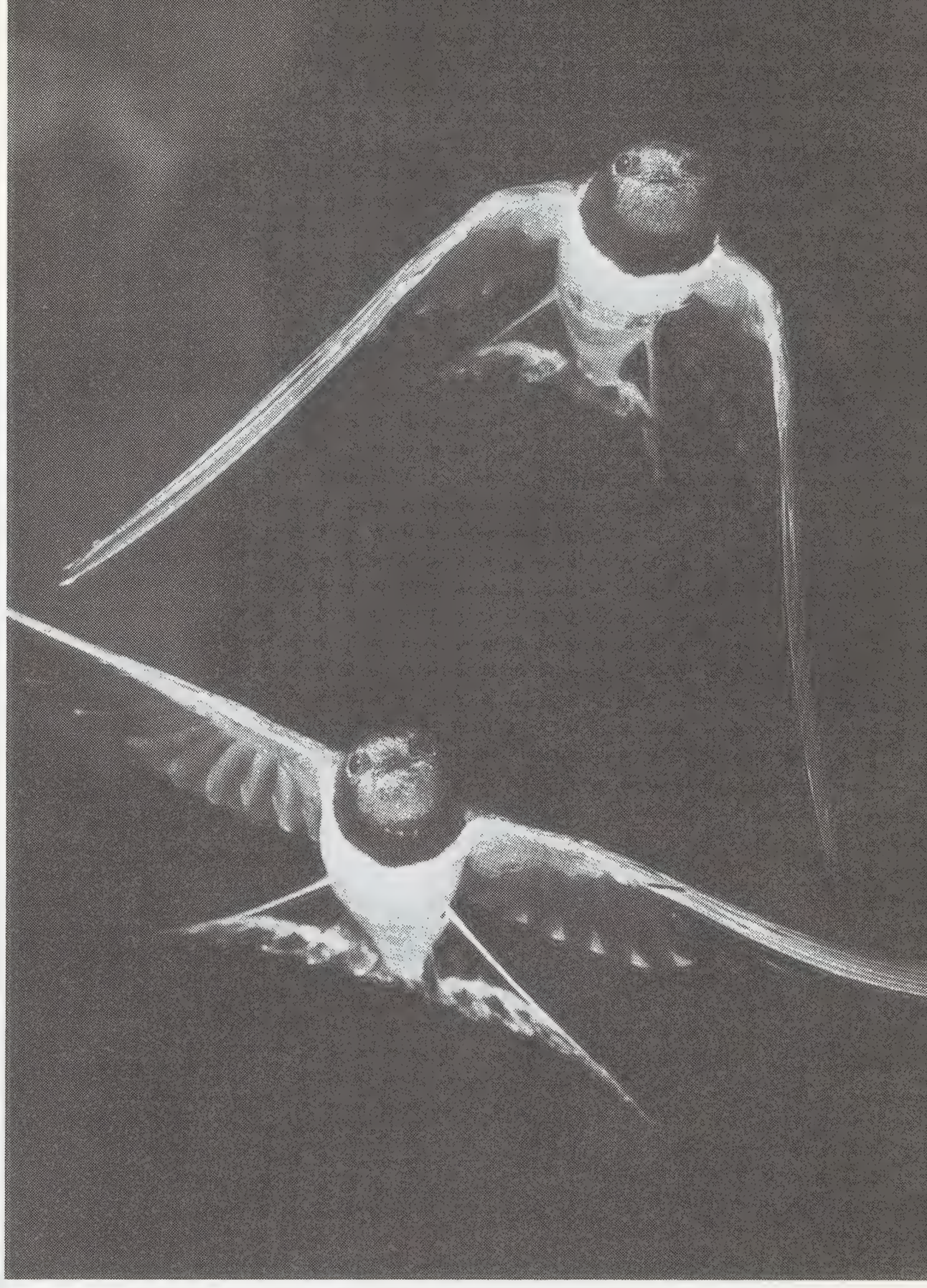


A European hoopoe in flight demonstrates how the long flexible primary feathers (the large feathers on the wing) flatten and overlap on the downward stroke of the wing, providing an unbroken surface to the air. The ends of the primary feathers move forward on the downstroke, thus serving as natural propellors, powering the bird's flight.

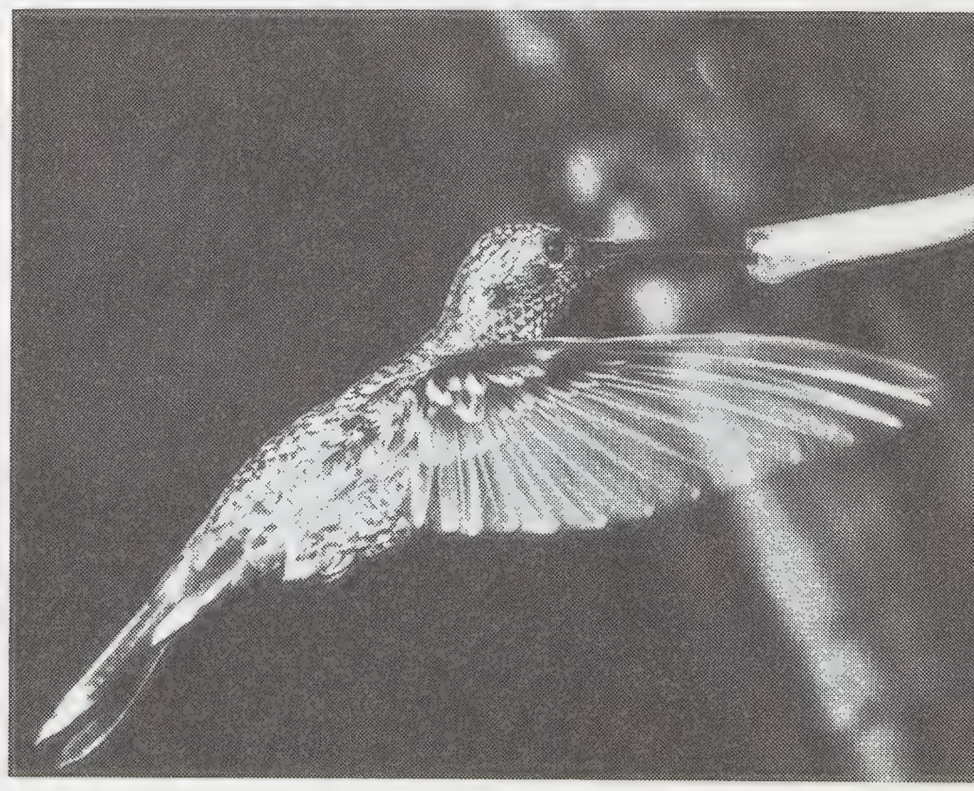
A swallow landing on a branch demonstrates the braking power of the primaries. Large muscles on the breastbone control the movement of the wing. There are two groups of such muscles, an inner set and an outer set. When the latter contract the wing is pulled downward. The smaller, inner set of muscles raises the wing, which because the wing meets less air resistance on the upstroke, is an easier task.

The barnswallow, right, captures flying insects for food. It has exceptional maneuverability when flying, because of its relatively long wings and the spread of its tail, which serves as a rudder.

Representatives of other groups of animals have taken to the air but none have been so successful in exploiting this part of the environment as the birds. The body of the bird, more or less spindle-shaped, is streamlined and slips through the air with minimum resistance. Its wings, powered by strong muscles that overlie the rigid breastbone, act as airfoils. The leading edge of the wing is thicker than the trailing edge; its upper surface is convex, its lower concave. In effect, the wing of a bird efficiently parts the air ahead of it while causing little turbulence in its wake. The feathers, which can be considered highly-modified scales, are enlarged on wings and tail, where they overlap, providing additional surfaces which support the bird in the air. The bones of birds are light but strong, and many have air pockets to lighten the bird's load even more.



The red-billed streamer tail, left, and other hummingbirds are capable of hovering flight because their wings are structured differently than other birds. The entire wing is almost rigid but can swivel, providing lift during flight without pushing the bird forward.



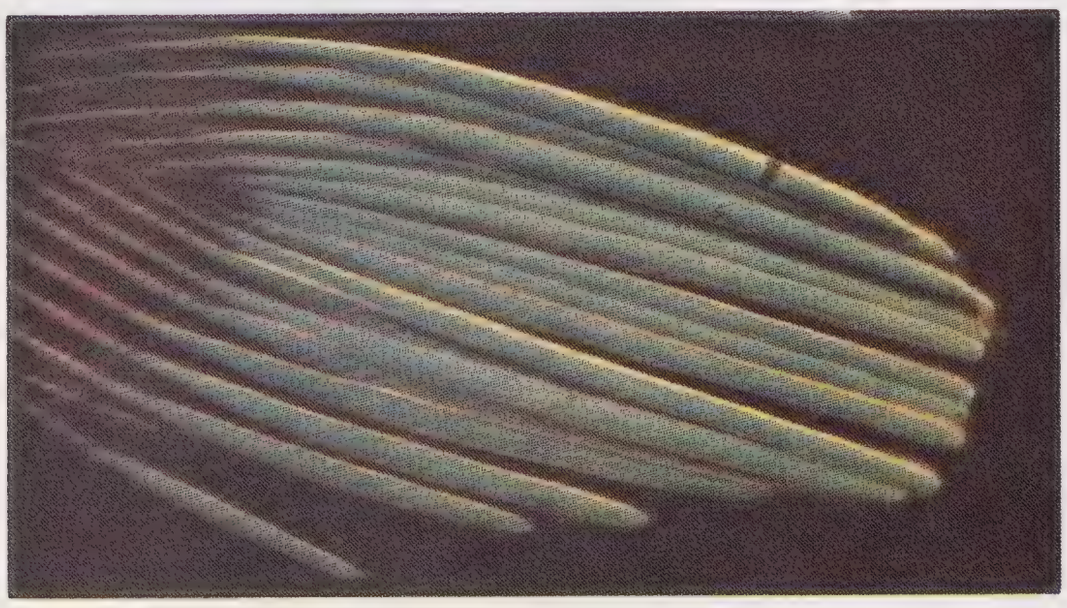
The hummingbird can fly backward, forward or it can hover. Its wing beat has been calculated at from 30 to 50 beats per second and is so fast that it is almost impossible to see with the eye alone.

Feathers -

A Superb Adaptive Feature

The feathers of a bird serve several purposes. They constitute a light, flexible but strong protection for a bird —— a barrier that protects the skin against wear and, because of air spaces, insulates against heat loss and injury. Moreover, the feathers of the wing and tail form surfaces that provide the lift required to support the bird when it is in flight.

The central structure of the feather is the shaft, or rachis. On either side of the central shaft is a vane, which in turn consists of individual barbs. The barbs are linked by tiny hooked structures, which give way under pressure but interlock once more when the feather is preened by the bird's bill. This arrangement makes the vane strong yet at the same time flexible. The photographs at left show the arrangement of barbs on a shaft, viewed from different perspectives.



Only birds have feathers. The total covering of feathers on a bird is called plumage, which is displayed in all its finery by this snowy egret, right. Feathers do not grow on all parts of the skin but only on special areas called pterylae, or feather tracts. Between the feather tracts are bare areas which zoologists call apteria.

The color of plumage ranges from drab to spectacular and in birds such as the Burmese fairy bluebird is incredibly beautiful.

Feathers are regularly replaced during the life of a bird; usually each feather is lost and replaced each year. This is accomplished by an orderly process called molt, which occurs gradually in healthy birds. The bird shown here is a purple-capped lory.

Owls such as the Eastern screech owl have tufts of feathers on the head that resemble ears. The tufts, however are not ears at all. The true ears are set within plumage to the side of the face. The edge of the vanes of the flight feathers are especially soft and downy, making for silent flight.

Some birds have plumage that has different color phases during the year. Others, such as the pigeons and doves, do not. The plumage of pigeons and doves —— seen here is a lesser thick-billed fruit pigeon —— is especially soft and thick.

The bill of most hummingbirds is long and thin, to penetrate deeply into flowers to obtain nectar. This is the Gould's sickle-bill hummingbird.

Teeth are absent in all living birds. However, the functions of biting, grinding and tearing have been taken over by the bill. The bill of a bird of prey, such as the South American condor, is adapted to tearing flesh.

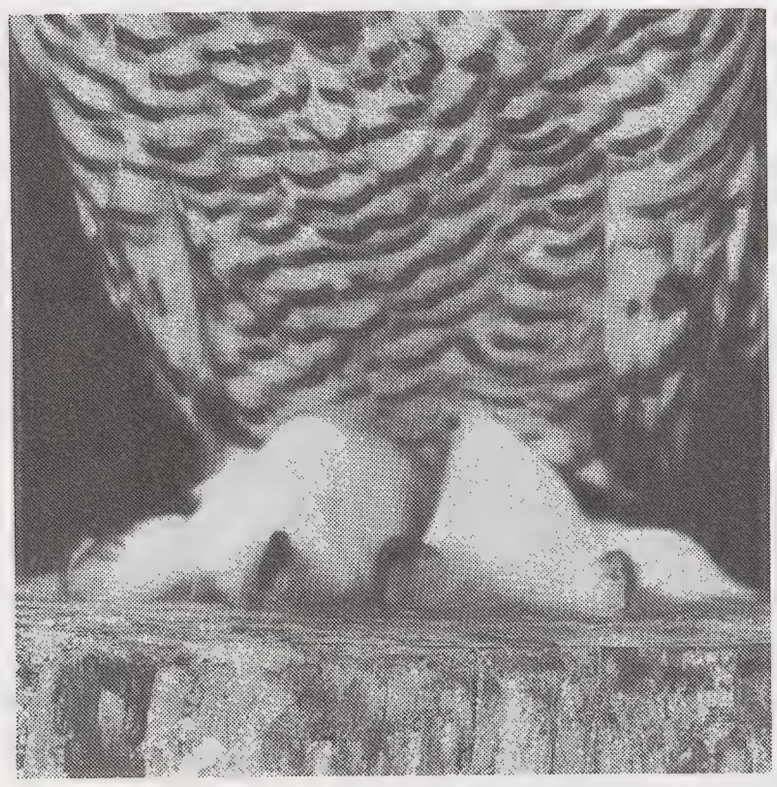
Kingfishers, even little ones such as this Natal pigmy kingfisher, have strong sharp bills suited to capturing fish.

Beaks and Feet-

They tell the story.

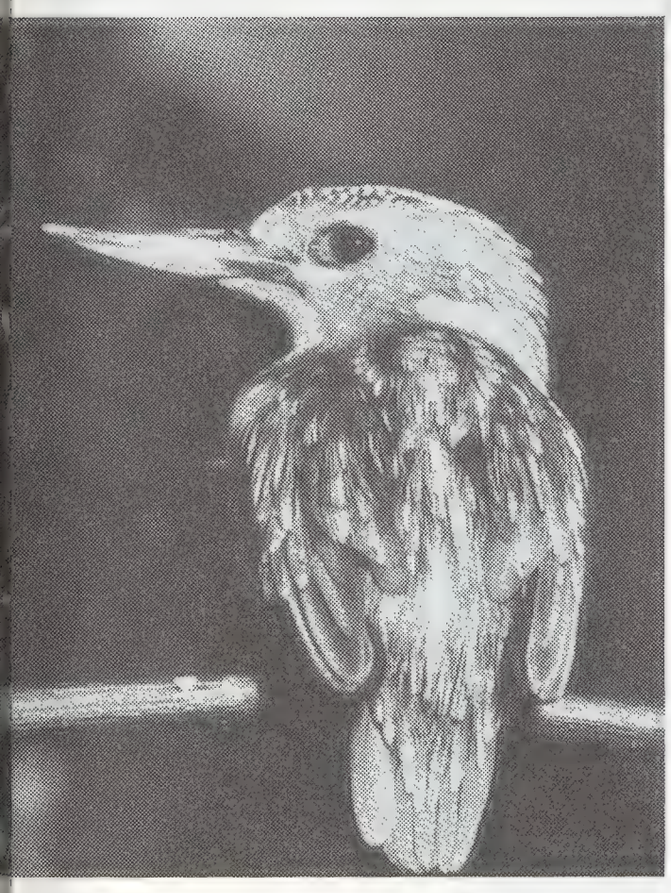
The beak, or bill, and feet of a bird can tell more about its way of life at first glance than any other features. The bill serves as both mouth and hands, the feet for a variety of functions, from arranging nesting materials to grasping prey. The different shape and structure of beaks and feet are obvious clues to the niches for which their owners have been adapted.

The powerful feet of owls and hawks are suited for grasping prey.



he bill of the woodpecker
— in this case a hairy
oodpecker —— chisels out
hunks of bark and rotting
ood so the bird can probe
racks and crannies with its
ng tongue in search of
nsects.

The unusual arrangement of the crossbill's bill enables it to extract seeds from evergreen cones.

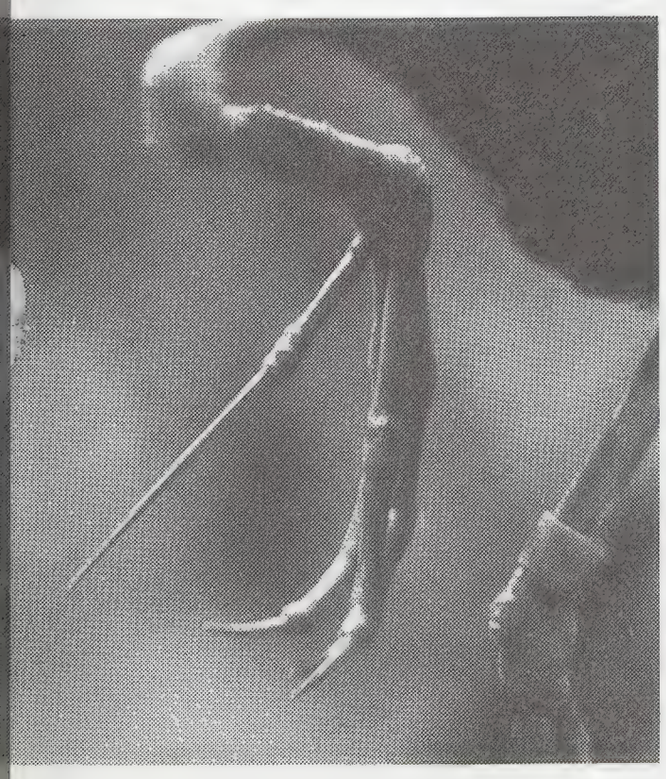


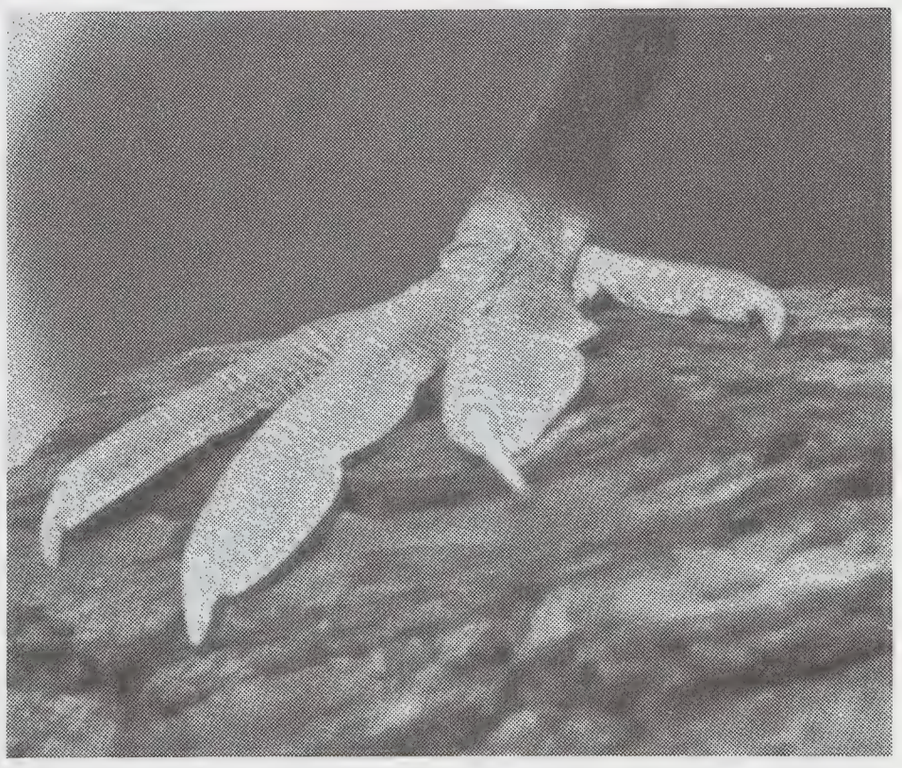
The secretary bird has the long, hooked bill of a bird of prey. It feeds on small animals it finds as it prowls the savannah.

he extra-long toes of the
acana enable it to walk on
loating vegetation and other
nstable footing.

The foot of the greater rhea, adapted for running and defense, has thick, short toes in relation to the bird's long legs.

The feet of water birds such as the finfoot have lobes that serve the bird as paddles.





The function of the huge bill of the toucan is something of a mystery. It may help the bird reach fruit and it may play a role in courtship display. Although it looks heavy, the bill is almost hollow except for a spongy structure within.

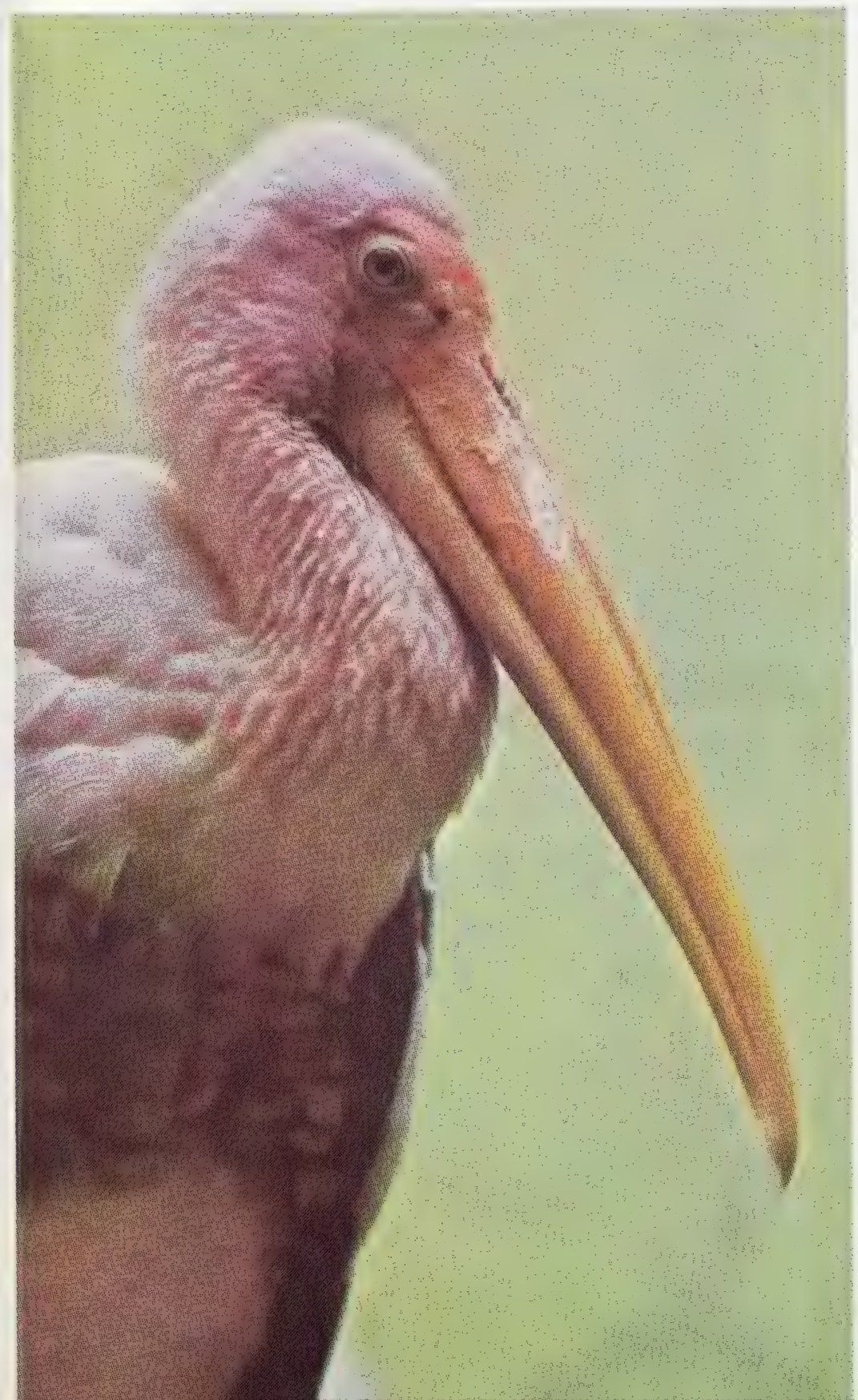
The bill of the touraco is generalized as befits its diet of berries, fruits, shoots and insects.

The function of the bill of the hornbill is not known but it may be used in nesting. The female hornbill, in all but two species, walls herself within a tree cavity with her eggs and, later, young. A small opening is left in the barrier, through which the male pushes food.

The curved, powerful beak of the Guilding's Amazon parrot easily cracks open seeds on which the bird feeds.

The long bill of the Indian wood ibis, actually a stork, aids in the capture of snails, frogs, snakes, mice and other small creatures.

The rather generalized bill of the cassowary suits its varied diet of fruit, small mammals and birds.



Big Bird, Little Bird

Bird Weights and Wingspans

		WEIGHT	WINGSPAN
South American Condor	*Vultur gryphus*	25 lbs.	9-10 ft.
Herring Gull	*Larus argentatus*	2 lbs.	4 ft., 6 in.
Wandering Albatross	*Diomedia e. exulans*	17 lbs.	up to 12 ft.
Trumpeter Swan	*Olor buccinator*	30 lbs.	8 ft., 4 in.
American Golden Eagle	*Aquila chrysaetos canadensis*	13 lbs.	6 ft., 8½ in.
Mourning Dove	*Zenaidura macroura*	4 oz.	
Cedar Waxwing	*Bombycilla dedorum*	33.8 grams	
Long-billed Star-throat Hummingbird	*Heliomaster longirostris*	8 grams	
Ruby-throated Hummingbird	*Archilochus colubris*	2.29 grams	

How Long Do Birds Live?

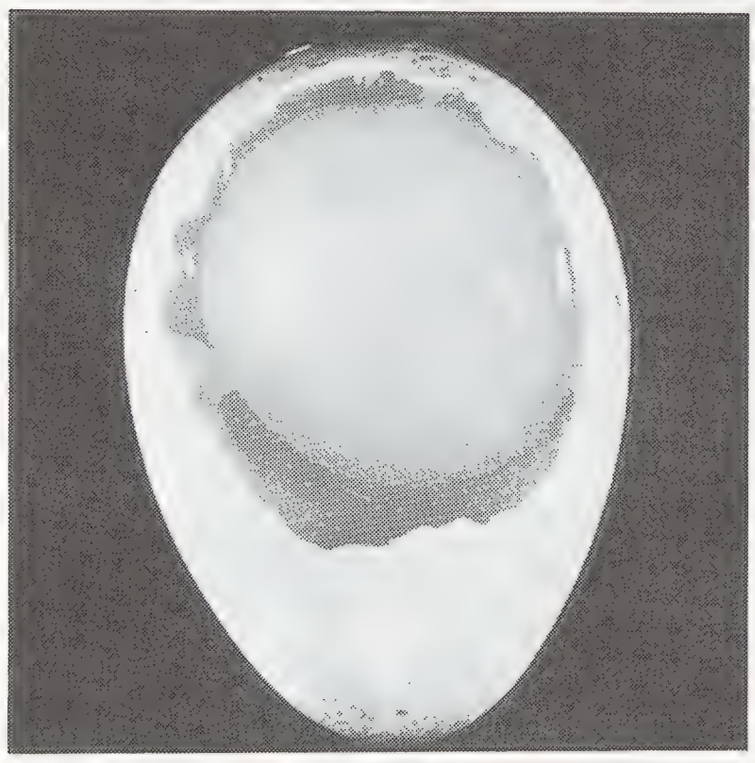
Longevity Records in the New York Zoological Society Collection

Livingstone's Touraco Southeastern Africa	*Tauraco l. livingstonii*	21 years, 11 months
Emerald-throated Hummingbird Less. Antilles south to Barbados	*Sericotes h. holosericeus*	10 years, 7 months, 10 days
Garnet Hummingbird Less. Antilles	*Eulampis jugularis*	9 years, 8 months, 7 days
Costa Rican Quetzal Costa Rica	*Pharomachrus mocinno costaricensis*	17 years, 5 months, 12 days
Long-crested Hornbill Malay Pen., Sumatra, Borneo	*Tropicranus comatus*	23 years, 10 months, 25 days
Javan Rhinoceros Hornbill Java & Sumatra	*Buceros silvestris*	23 years, 11 months, 14 days
Azure Jay S. Brazil to N. Argentina	*Cyanocorax caeruleus*	38 years, 11 months, 29 days
Curl-crested Manucode Fergusson Island S.E. of New Guinea	*Manucodia c. comrii*	18 years, 1 month, 15 days
Vieillot's White-throated Robin S.E. Brazil	*Turdus albicollis*	11 years, 5 months, 6 days
Kenya Amethyst Sunbird Africa	*Nectarinia amethystina doggetti*	16 years, 5 months, 16 days
Purple Long-tailed Glossy Starling East Africa	*Lamprotornis p. purpuropterus*	19 years, 11 months, 25 days

The Egg and the Nest

The egg of the bird always is fertilized internally. Bird eggs contain a large amount of yolk and are protected by hard, limey shells. They vary in size from the softball-size egg of the ostrich to the eggs of various hummingbirds, which are as small as a pea. Each species of bird has its own particular nest. Nests range in size and conformation from the hanging baskets of the caciques and the massive bundles of sticks of eagles and ospreys, to the delicate cups of spider webs built by hummingbirds and the burrows and hollows of kingfishers and woodpeckers.

These photographs illustrate the development of a turkey embryo(1). The newly-fertilized egg, just laid, offers little evidence of the young turkey, but within five days (2) a hint of the embryo is visible among the blood vessels that link the embryo to the yolk. Twelve days after the egg was laid the yolk is shrinking visibly (3) and the embryo is connected to it only by one link. The organs of the developing turkey chick are visible at 15 days (4) and at 23 days the chick (5) is nearing the time it will emerge from the egg, about a week later (6).



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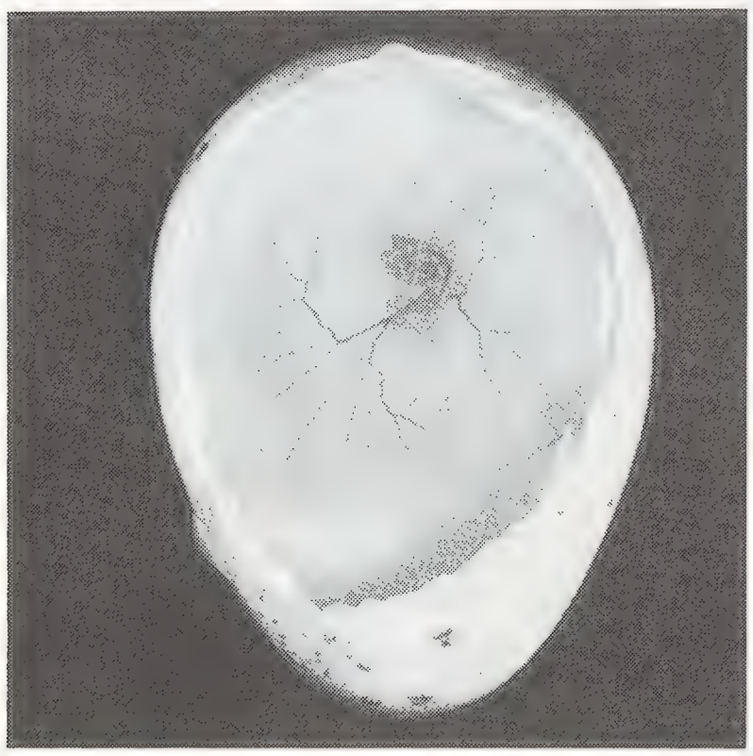

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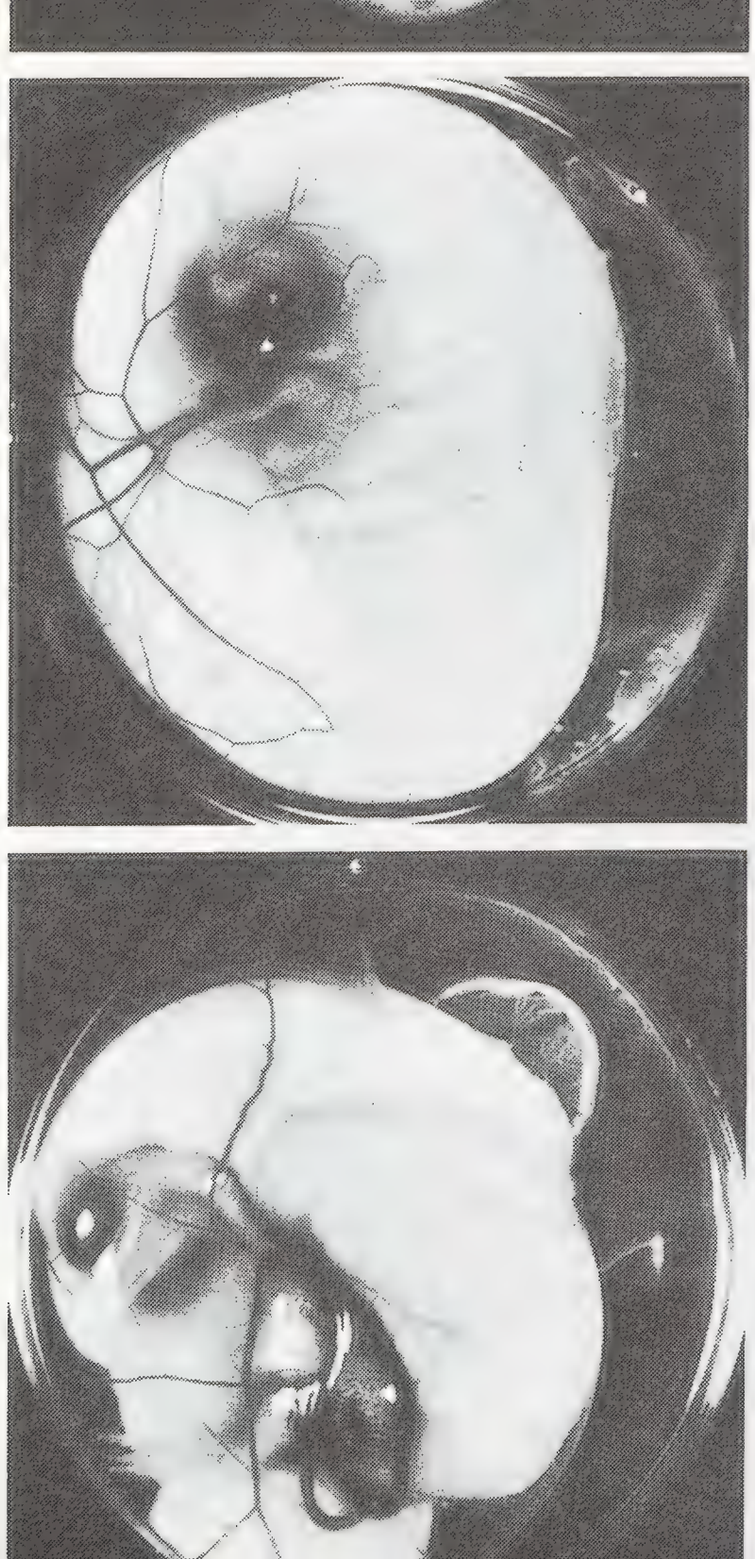

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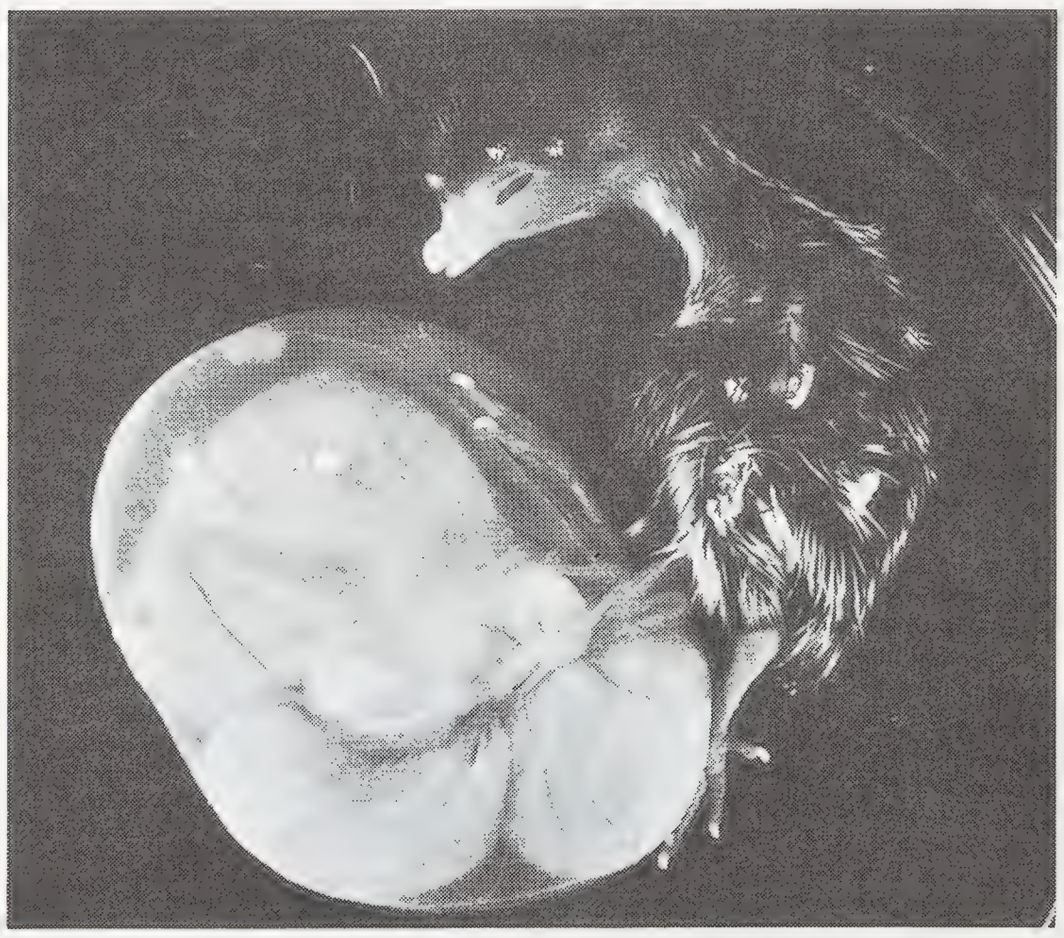
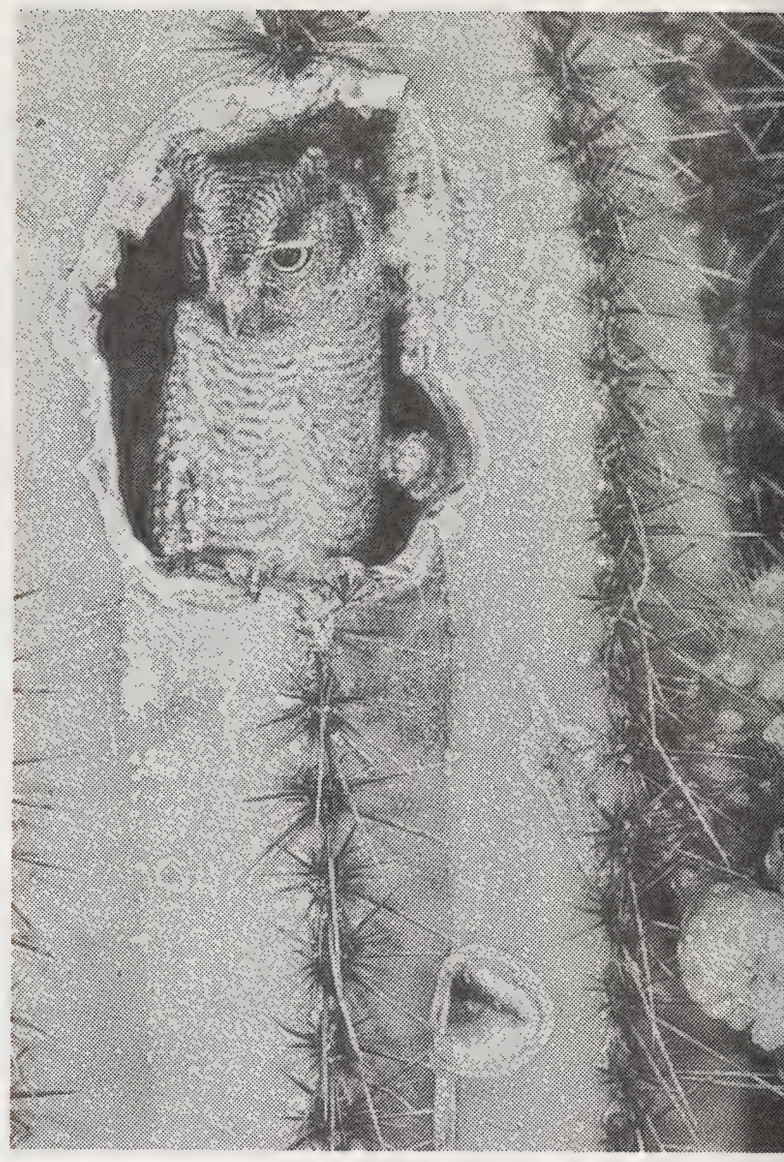


5

6

A young cowbird has hatched in the nest of a phoebe. The cowbird will crowd out the legitimate nestlings when they hatch.



This screech owl has roosted in a hole within a saguaro cactus. Screech owls, common throughout most of the United States, nest in a variety of holes and cavities.

Holes in trees are used as nest cavities by tree swallows.

The cacique builds spectacular basket nests. This colony of cacique nests was photographed in Trinidad.

The scarlet ibis builds a nest of twigs and sticks.

The barn swallow constructs a nest of mud amidst the timbers of buildings. They often nest in garages and even have been known to set up housekeeping atop a front porch light.

This sun bittern accepted an artificial nest of Spanish moss at the Bronx Zoo.

Many birds of prey, such as the osprey, building huge nests of sticks high in tree tops.

Colonies of bank swallows burrow into the banks of gravel pits and rivers.

Why They Go and How They Get There

Migration and Navigation of Birds

Long before recorded history began humans must have pondered the reasons behind the disappearance of many kinds of birds in the Autumn and their return in the Spring. The seasonal migrations of birds must have been events of great significance to prehistoric peoples, who necessarily were much closer to nature than most people today. However, men still cogitate over what prompts the birds to come and go, and how they find the routes to destinations that sometimes are a half-world away.

The chain of events that culminate in migration is not completely understood but researchers have removed much of the mystery from bird migration. It is the result of a complex pattern of interplay and feedback between a variety of elements —— external cues such as changes in the length of day and, for instance, internal activity such as the release of hormones into the blood by the endocrine glands. Migration is merely a phase in the annual cycle of birds, which includes molt and breeding. The timing of migration, however, is awesome in its preciseness.

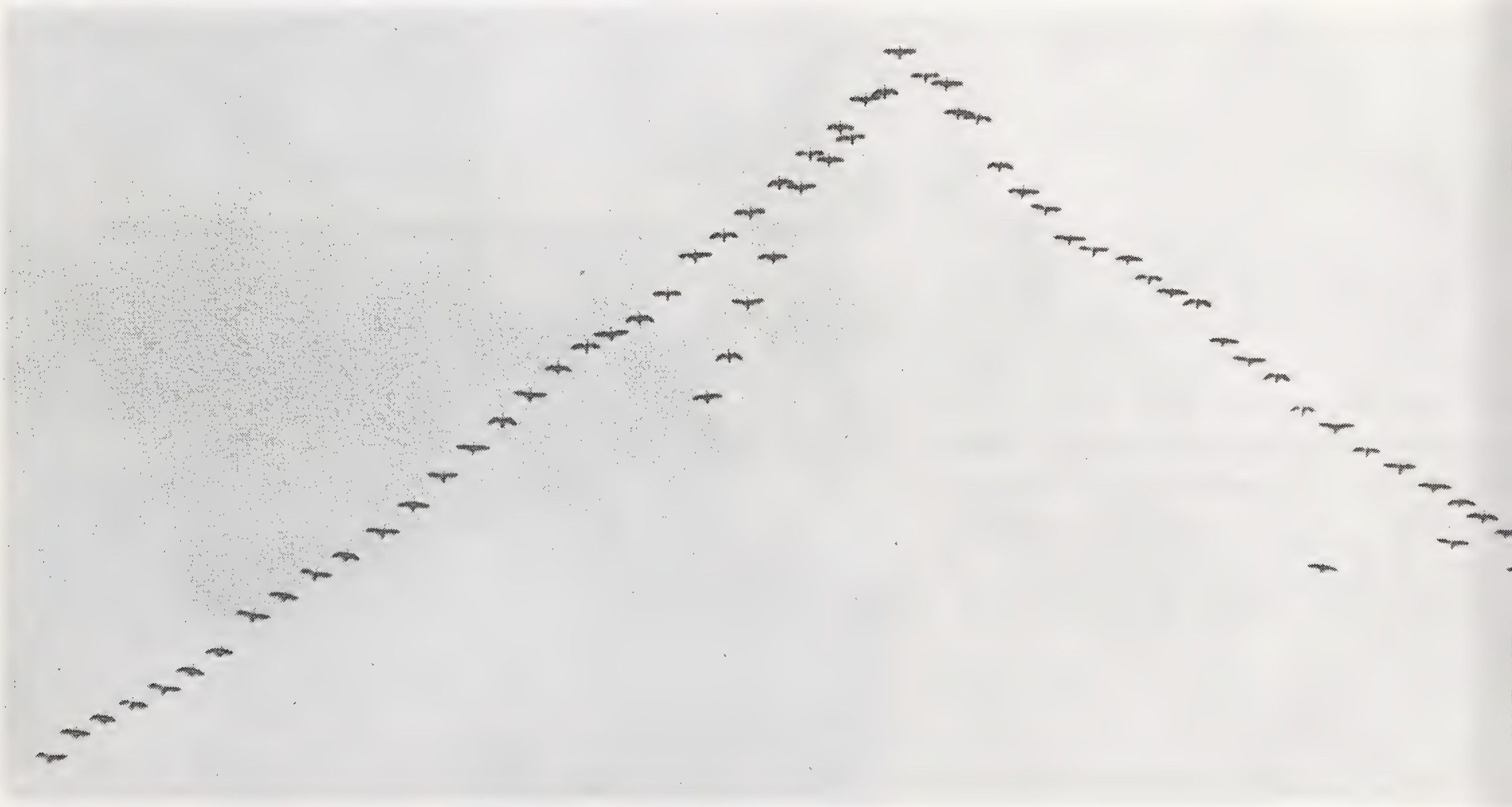
Shore birds by the millions leave warmth and

The migratory route of the Arctic tern stretches almost from one pole to another.

food in South America and start for Arctic nestings grounds while these are still swept by blizzards. But the trip is scheduled so that when the birds arrive the northlands are warming, and by the time courtship has been completed, eggs produced and incubated, and young hatched, a food supply is available.

In the fall the migratory birds grow increasingly restless, flocking, fluttering about, and making an increasing number of false starts on the southward journey. But one day they do not return and the long trip south begins in earnest. The northlands still bask in mild temperatures, food remains abundant, yet still the birds leave. And it is well, for before many of them finish the journey the place they left will be a wasteland once more.

Canada geese form a distinctive wedge as they migrate.



Some birds travel close to the ground, others migrate at altitudes of almost a mile. Most migrations are latitudinal, from north to south, and some of these span vast distances. The Arctic tern undertakes an annual round-trip of 22,000 miles from the Arctic to the seas that fringe the Antarctic. The golden plover migrates from Hudson Bay to Argentina, and the bobolink from the United States to southern Brazil.

Other migrations are altitudinal, spanning climatic zones by movement up and down mountains. Mountain quail in the California mountains migrate from 9,500 feet to 5,000 feet in autumn. Juncos in the Smoky Mountains move into the valleys for the winter.

Man has altered the migratory habits of some Canada geese. Many geese from northern areas now stop for the winter at coastal grain fields in Maryland. In years past, before the Maryland fields became so extensive, the geese wintered farther south.

The way in which birds navigate on migratory flights is even more of a puzzler than the influences that trigger migration. In recent years, however, scientists have presented considerable evidence that many birds navigate by means of the sun and the stars.

Many shorebirds that winter in South America pass through the New York metropolitan area during May as they head for breeding grounds in northern Canada.

Display and Courtship

To Perpetuate the Species

An incredible variety of displays, some quite spectacular, are involved in courtship rituals of birds. Cocoi herons, page opposite, engage in mutual display, with plumes waving. The facial appendages of the three-wattled bellbird, right, are a part of the male's display ornamentation.

Feathers ruffled, two male sage grouse, above, contest territory with a strutting, dramatic display. Perhaps the most dazzling display of all is that of the birds of paradise. At the right, a male greater bird of paradise waves his gorgeous plumes during a display.

Birds of New York

Where You Can Find Them.

BRONX PARK
(Bronx Zoo and Botanical Gardens)

Excellent for migratory wood warblers, thrushes in Spring and Autumn. Waterfowl, particularly shovelers, in Winter.

PELHAM BAY PARK
(Bronx)

Wintering owls, migratory water fowl.

LITTLE NECK BAY

Wintering waterfowl, gulls; migratory shore birds.

JAMAICA BAY

Huge flocks of waterfowl in winter; wading birds and shore birds.

VAN CORTLANDT PARK
(Bronx)

Migratory songbirds; wintering owls.

CENTRAL PARK

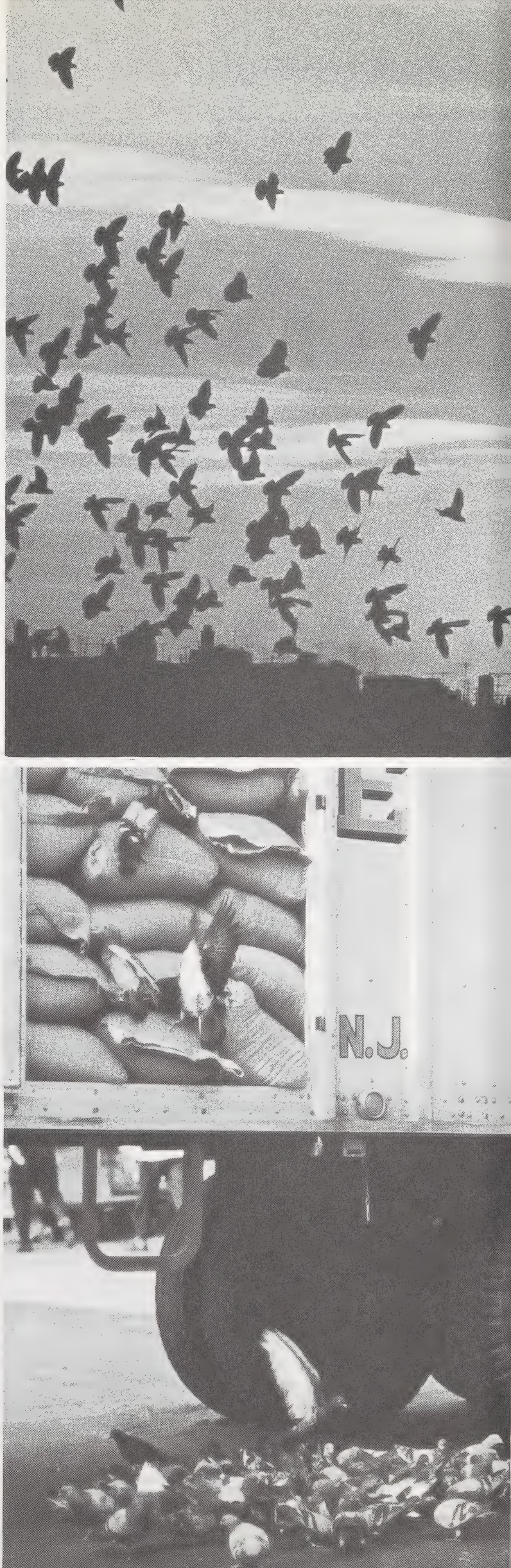
Migratory songbirds.

FORT TRYON PARK
(Manhattan)

Songbirds.

POUND RIDGE RESERVATION
(Westchester County)

A wide variety of birds, including those seldom seen in New York City proper, such as ruffed grouse, pileated woodpecker.



Many Birds are a Wingbeat from Extinction

ENDANGERED BIRDS OF THE UNITED STATES

Hawaiian Dark-rumped Petrel
Pterodroma phaeopygia sandwichensis
The Brown Pelican
Pelicanus occidentalis
Nene or Hawaiian Goose
Branta sandvicensis
Aleutian Canada Goose
Branta canadensis leucopareia
Tule White-fronted Goose
Anser albifrons gambelli
Laysan Teal
Anas platyrhynchas laysanensis
Hawaiian Duck (Koloa)
A.p. wyvilliana
Mexican Duck
A. diazi
California Condor
Gymnogyps californianus
Florida Everglades Kite
Rostrhamus sociabilis plumbeus
Hawaiian Hawk
Buteo solitarius
Sou. Bald Eagle
Haliaeetus l. leucocephalus
Am. Peregrine Falcon
Falco peregrinus anatum
Attwater's Greater Prairie Chicken
Tympanuchus cupido attwateri
Masked Bobwhite
Colinus virginianus ridgwayi
Whooping Crane
Grus americana
Florida Sandhill Crane
G. canadensis pratensis
Yuma Clapper Rail
Rallus longirostris yumanensis
Hawaiian Common Gallinule
Gallinula chloropus sandvicensis
Eskimo Curlew
Numenius borealis
Puerto Rican Parrot
Amazona vittata
Ivory-billed Woodpecker
Campephilus p. principalis
Hawaiian Crow
Corvus tropicus
Puaiohi (Small Kuai Thrush)
Phaeornia palmeri
Nihoa Millerbird
Acrocephalus kingi
Kauai (or OO AA)
Moho braccatus
Crested Honeycreeper
Palmeria dolei
Akiapolaau
Hemignathus wilsoni
Kauai Akialoa
H. procerus
Kauai Nukupuu
H. lucidus hanapepe
Laysan Finch
Psittirostra c. cantans
Nihoa Finch
P.c. ultima
Ou
P. psittacea
Palila
P. bailleui
Maui Parrotbill
Pseudonestor xanthophrys
Bachman's Warbler
Vermivora bachmanii
Golden-cheeked Warbler
Dendroica chrysaparia
Kirtland's Warbler
D. kirtlandii
Dusky Seaside Sparrow
Amospiza nigrescens
Cape Sable Sparrow
A. mirabilis

Literally billions of passenger pigeons once inhabited North America. Victims of overhunting and habitat destruction, the passenger pigeon has been extinct for more than a half-century.

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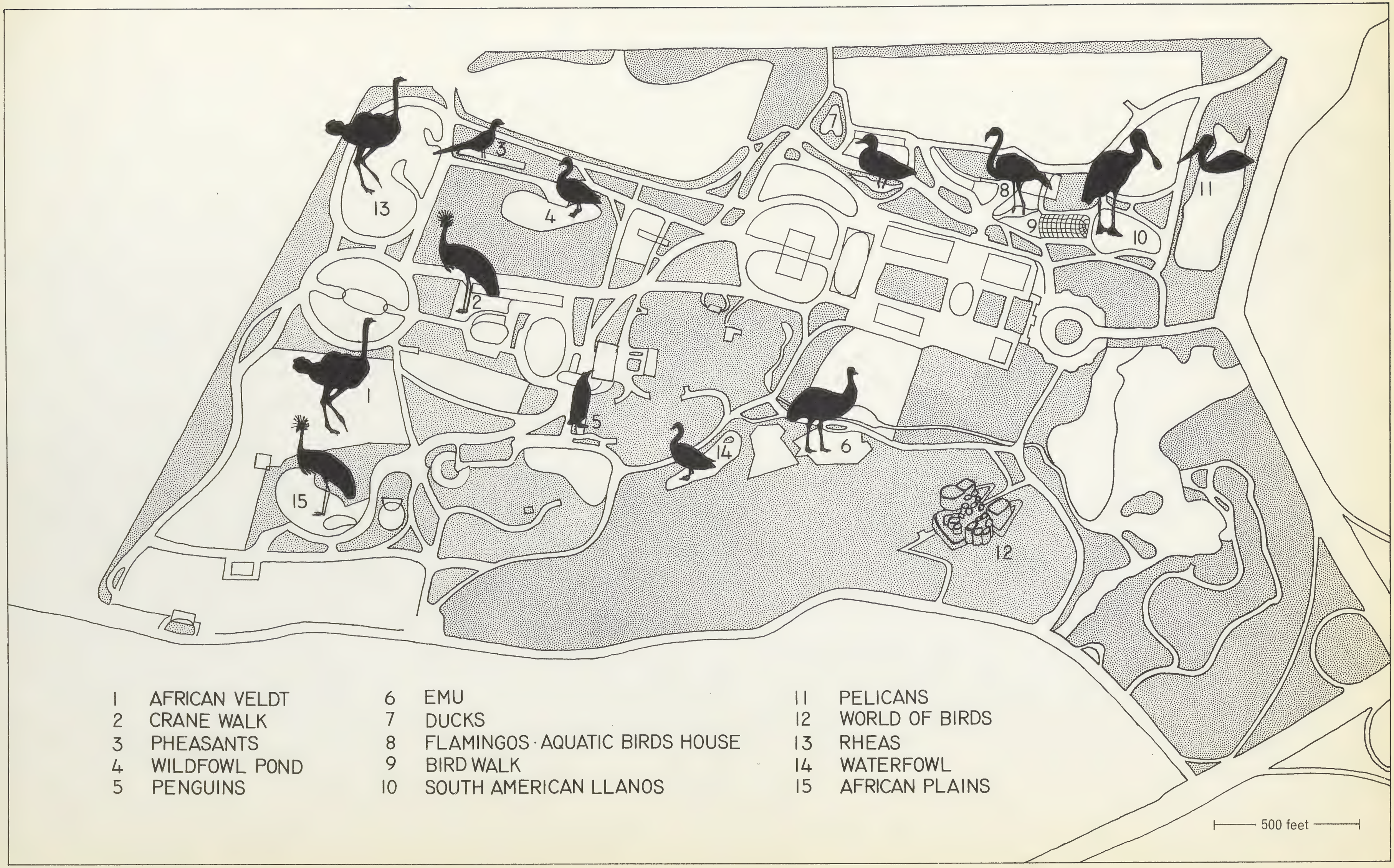

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Animal Kingdom

October 1972

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The Other Panda

Animal Kingdom

MAGAZINE OF THE NEW YORK ZOOLOGICAL SOCIETY

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Sixty Million Bison
by G. Earl Chace
The buffalo roams once again on the western prairies—thanks to a nucleus herd preserved at the Bronx Zoo. Hunted to near-extinction a century ago, the fall and rise of the American bison parallels the history of the west.

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Horns and Hoofs in the Catskills
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The Catskill Game Farm is a collector's showcase of horned and hooved animals from all parts of the world. It represents the lifelong dream of its founder, who seeks both rare and common species to complete his collection.

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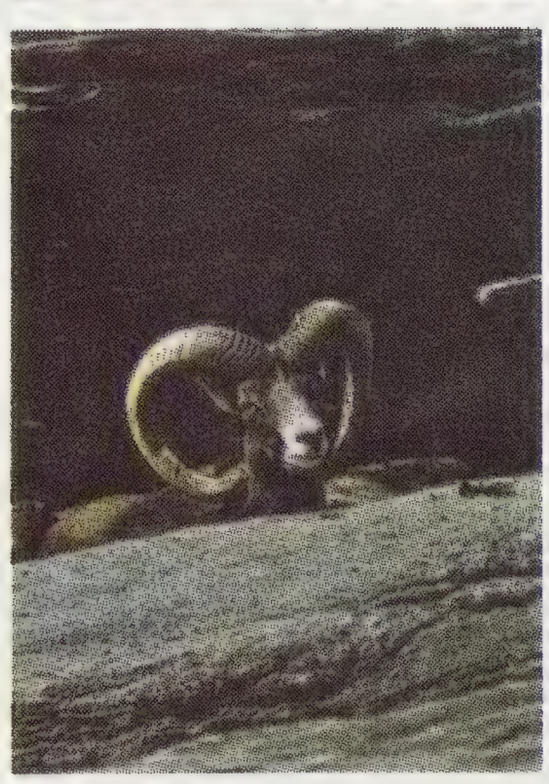
Tracking the Mouflon of Corsica
by Walter H. Kilham, Jr.
The wild sheep of Corsica have retreated into the island's rugged mountains to escape man's encroaching presence. Once creatures of the forest, the wary animals now seek the security of remote and jagged terrain.



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Vanishing Species *Inside Back Cover*

About the cover

The red panda's favorite haunt is a tree crotch high above ground, where it can nap comfortably most of the day. The red-furred ring-tailed panda resembles a fox or raccoon at first glance, but the family connections of this "lesser" panda have yet to be established. *Photo by N. Smythe from National Audubon Society.*

Back cover: The Sonoran green toad from Arizona is one of several American species of toads whose small habitat makes them vulnerable to lumbering, urban growth, and over-collecting. (See Vanishing Species, inside back cover.) *NYZS photo by Bill Meng.*

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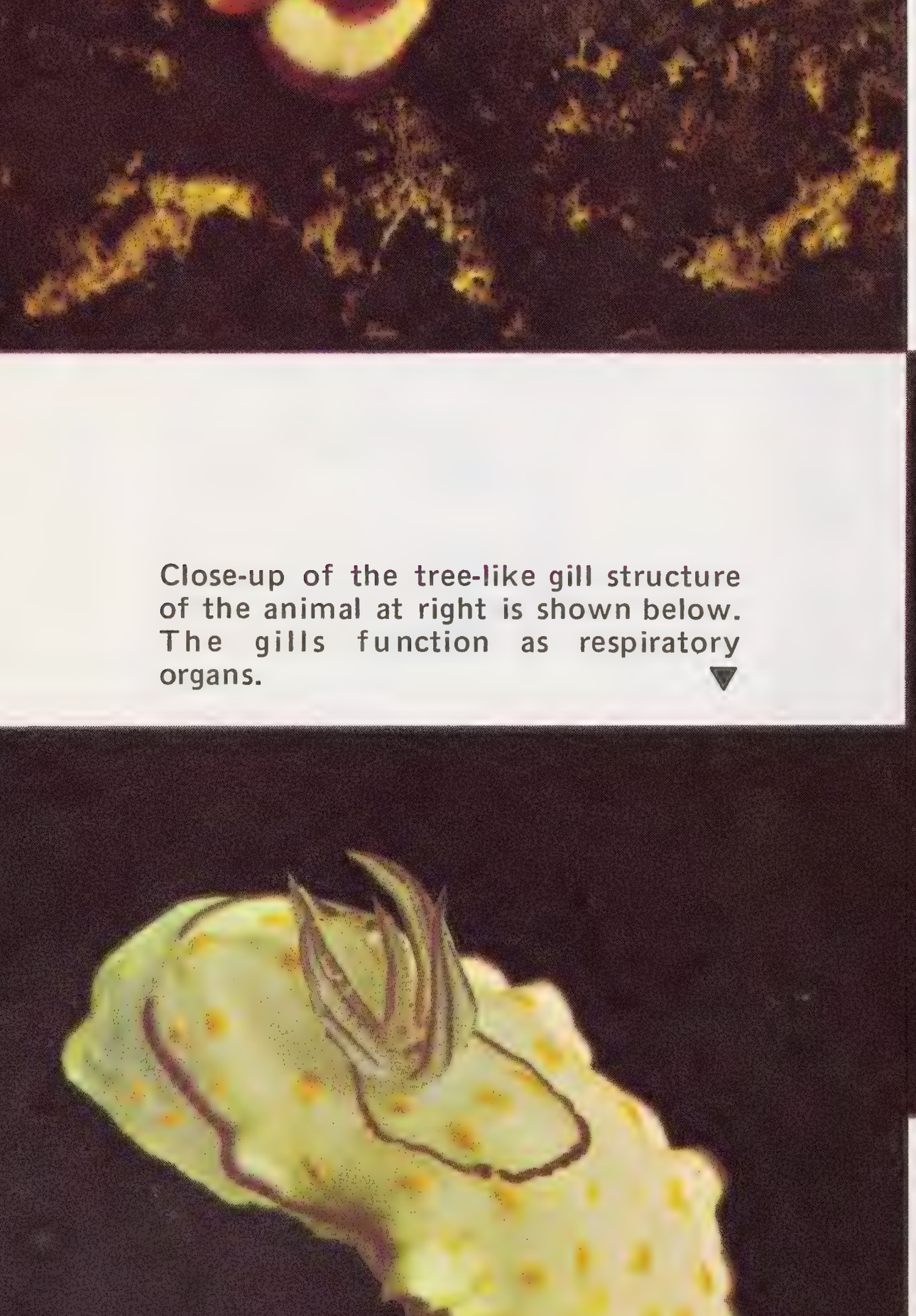
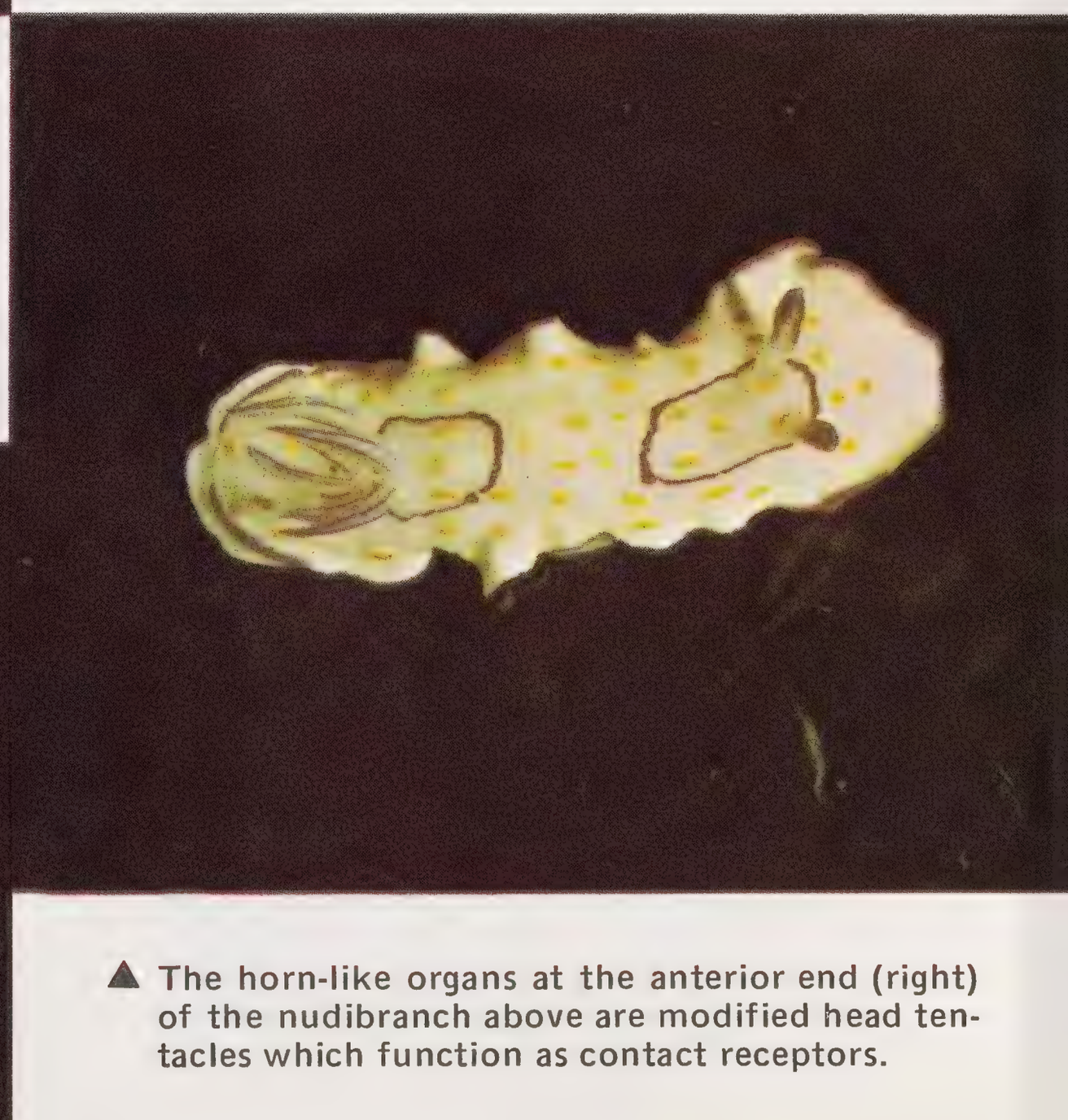
The sea slug above, one of the smaller species, is about one inch long. Other species may be four inches and longer.

◀ Like all snails, the striped sea slug at left has a foot (top) with which it slithers and clings to rocks and other surfaces.

Close-up of the tree-like gill structure of the animal at right is shown below. The gills function as respiratory organs. ▼





▲ The horn-like organs at the anterior end (right) of the nudibranch above are modified head tentacles which function as contact receptors.

The colorful stripes of the sea slug below may be defensive coloration — predators who know that the animal is not tasty easily recognize and avoid it.

Naked Snails

Photography by Walter Lerchenfeld
Text by George D. Ruggieri, Asst. Director, Osborn Laboratories of Marine Sciences.

Some of the most colorful creatures in the ocean are the sea slugs – snails without shells that glide gracefully through the water. These beautiful animals usually escape the glances of the casual diver because they blend so perfectly with the colors of the organisms on which they browse or feed.

Sea slugs do not seem to fit the classical image of snails (gastropods). Some snails are delicious morsels at the gourmet's table (escargot and abalone), others are potently venomous (certain cone shells), and still others are intermediate hosts in human parasitic diseases. But sea slugs are, indeed, gastropods, belonging to the subclass *Opisthobranchia* and the order *Nudibranchia;* which is to say: they are snails with gills in the rear (*opistho,* rear; *branchia,* gills). Their gills are naked or exposed *(nudi,* naked; *branchia,* gills).

But nudibranchs are also naked in that they lack a shell. Unlike the typical snail which is often rather drab and which slowly slithers

along the bottom encased in a formidable shell, the sea slug, freed of its shell cover, is more mobile and plastic. Bold splashes of color combined with delicate excrescenses on its body impart a kaleidoscopic appearance. Some opisthobranchs glide through the water with a grace reminiscent of a prima ballerina.

Each species has its own rather specific diet-delight. Some feed exclusively on seaweeds, others on planktonic organisms, still others on sponges, jellyfish, bryozoans, fish eggs, etc. Some are suction-feeders and others, such as sponge-eating sea slugs, make use of extracellular enzymes.

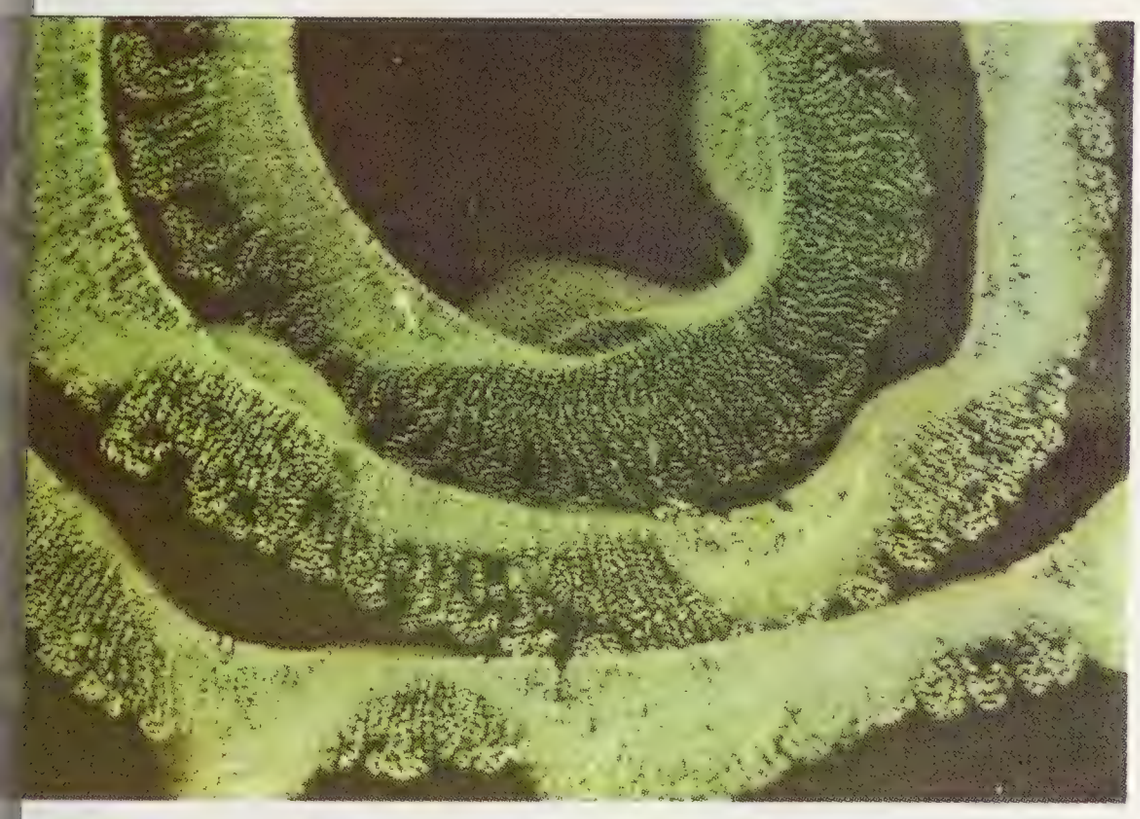
Some sea slugs obtain undischarged stinging-cells (nematocysts) from jellyfish, hydroids, and anemones on which they feed. The sea slugs retain these stinging-cells as part of their own defensive arsenal, releasing them when they are disturbed. Sea slugs also have other ways of warding off predators. They possess what are appropriately called repugnatorial glands. These glands secrete acids or bitter-tasting substances which make it extremely distasteful to potential predators.

Sea slugs are simultaneous hermaphrodites with synchronous ripening of male and female reproductive cells (gametes). In many, copulation is reciprocal; while in others, chains of individuals are formed in which each acts as male to the animal below. They produce large numbers of eggs embedded in gelatinous secretions. Many sea slugs gyrate slowly as the egg mass leaves the body forming a tight spiral which is anchored to seaweeds, hydroids, bryozoans, and other surfaces. The color of the egg mass is often of the same color as the adult.

The photographs on these pages were taken at the Osborn Laboratories of Marine Sciences at the New York Aquarium, Brooklyn, N.Y.

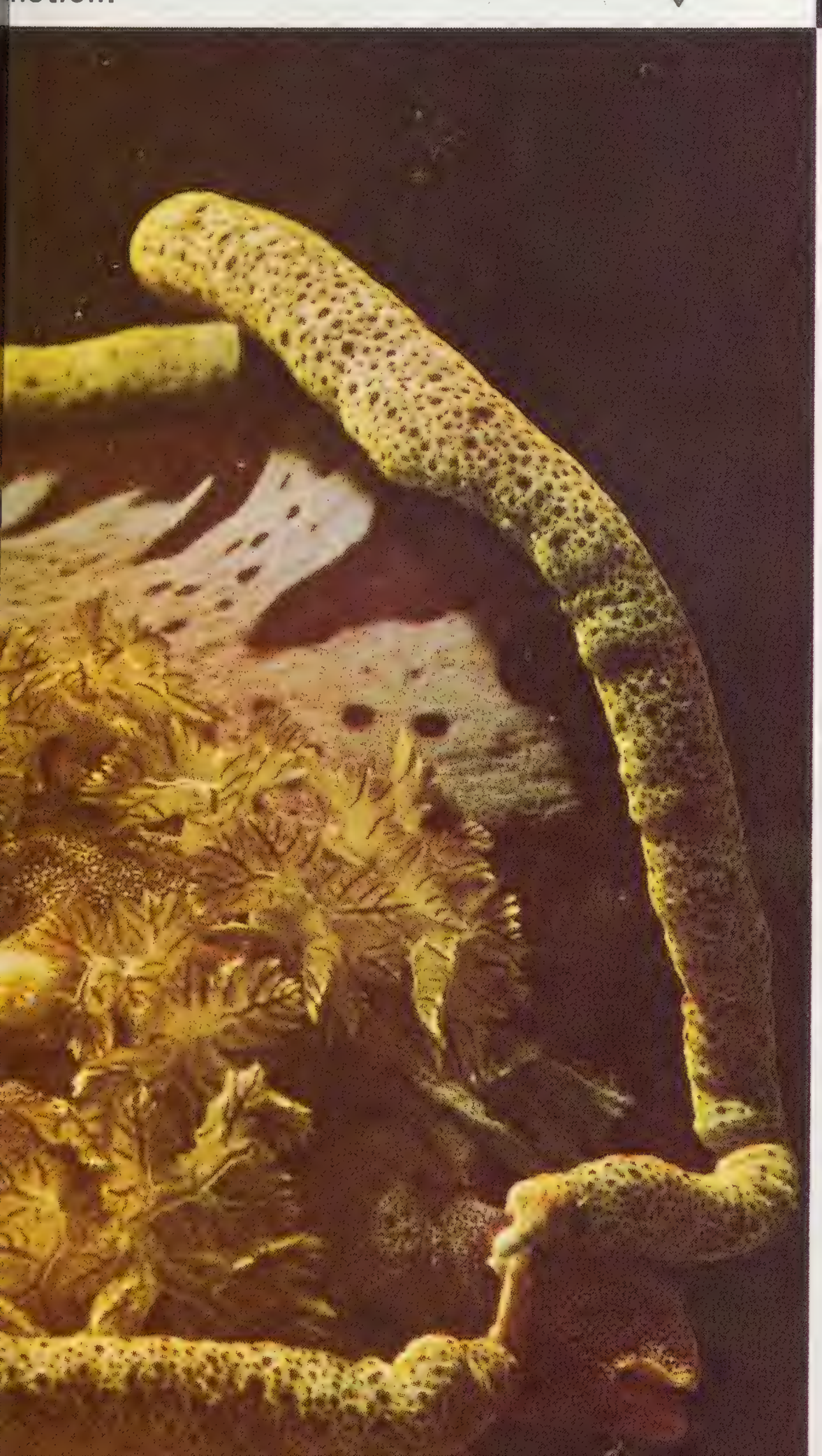
ea slugs, like those at left, can act
male or female. Mating can
ccur in pairs or chains of animals.

The spirally-deposited jelly ribbon, below, contains an abundance of sea slug eggs — each small dot represents one egg. ▼



Sea slugs, like the one at right, ▶ are ubiquitous creatures — they are found on rocks and coral along the coast and in tidal pools.

he branched gill structure of this large (four-
nch) sea slug is revealed in this close-up photo.
he slug swims with a graceful undulating
motion. ▼



The beautiful animal below, and the one at left, are swimmers; the others pictured here are crawlers. The leaf-like organs are used for swimming, respiration, and to house stinging cells obtained through feeding. ▼

The Other Panda

Only 17 giant pandas had ever been seen alive in western lands before those last two furry newsmakers from China were put on display at the National Zoo in Washington, D.C., in April 1972. Yet this roly-poly pierrot in fur had already become such an all-out favorite, both as a plush child's toy and as a playful living animal seen within a zoo enclosure, that almost no notice at all has been paid another, smaller animal that also wears the panda name.

This so-called "lesser" panda was actually the first to wear the shared label. In fact, this smaller relative with its appealing foxlike face, coloring, and size was making headlines in 1821, a good 48 years before the western world first learned of the giant panda's existence.

Perhaps the small red-coat's prior claim to the panda name has been overlooked because it has not been a common zoo exhibit. Even those on display never drew the ballyhoo barrage of pictures, publicity stories, and toystore duplicates that kept the larger panda in the spotlight. Yet the red panda has appealing ways, too, and its discovery makes a story well worth telling.

The first European to see this fox-furred one in the wilds of its Himalayan homeland was probably a Danish botanist named Nathaniel Wallich, director of the botanical gardens at Calcutta. Wallich spent much time afield seeking new plant specimens and often took along other Europeans interested in India's animals, or else brought them any unusual animals his hunters collected. The pelt of the first red panda on record came from Nepal and went to his friend, Major-General Thomas Hardwicke, a British army officer and amateur naturalist, about to return to England in retirement. Hardwicke collected some store of information about its habits and habitat, including the local name of *wha,* or *chitwha* – which he took to be an echo of its wailing cry.

On November 6, 1821, Hardwicke displayed his mounted specimen to the excited members of the London Linnean Society, who were all agog over being on hand for the first European exhibit of a new species. They took one look at the impish masked face and the ring-marked bushy tail, and promptly dubbed it the Himalayan raccoon. Another off-the-cuff choice was Himalayan fox.

Virginia C. Holmgren is the author of numerous animal books and is a nature writer for Portland's "The Oregonian." Her recent book on the Chinese pheasant, "The War Lord," is now being produced as a motion picture.

A panda by any other name

Hardwicke, for all his keen interest, evidently did not know that any discoverer of a new species should publish its description with proper terminology as soon as possible, in order to get it on official listings, and thus have the honor to name the species by giving it a two-part Latin label (genus + species), according to the system set down by the great Swedish classifier, Carolus Linnaeus.

oto by Richard Parker from National Audubon Society

Hardwicke's failure to take this step or to publish any account until 1827 left the official naming open to whomever might publish a classification of the new species first.

As it happened, another *wha* was found very shortly thereafter by an intrepid young French collector, Alfred du Vaucel, who was in India as a representative of the French natural history museum. He was related to the brothers Georges and Frederic Cuvier, famous experts on the museum staff; Frederic examined the skin and bones of this reddish-furred ring-tail, which he thought the most beautiful creature he had ever seen.

Luckily, Du Vaucel had included jaws, teeth, and paws – the very structures that identified this as belonging to a new genus – and in June 1825, Cuvier published an account, complete with artist's sketch and Latin label, *Ailurus fulgens. Ailurus* for the catlike appearance, he wrote, and *fulgens* for its brilliant colors. For the vernacular name, he used the word *panda,* but since his specific label of *fulgens* means "shining" or "fire-colored" (in other words, red), the usual name became "shining panda" or "red panda" in translation.

Fire fox and mountain baby

The red panda eats bamboo shoots and leaves, among other things, but neither Hardwicke, Hodgson, nor Du Vaucel mentioned the bamboo as the exclusive diet or even the most favored food. Panda preference for bamboo did not become part of the panda story until the giant panda came on the scene. Eventually a French naturalist-priest, Father Armand David, would find both pandas in China and report that the little red-coat was known there as *hun-ho,* meaning "fire fox," or as the "mountain baby." The red-coat's custom of catlike hissing and its costume of ruddy bearlike fur also led to names meaning bear-cat and red bear-cat.

Of course, any animal that ranges from the western Chinese provinces of Yunnan and Szechuan south and east to the Himalayan lands of Nepal, Sikkim, Burma, and Assam (as little red-coat does) would pick up a different name in almost every dialect spoken over its widespread territory. So neither *wah* nor *hun-ho* nor *panda,* nor any other native name could make exclusive claim to being the one and only correct label. Public usage of animal names may go by whim and whimsy, but by the rules of modern zoological nomenclature, the correct scientific label is the one first in print with proper identification (unless later revised by official action), and Cuvier settled this point with *Ailurus fulgens,* the panda.

Tie-dyed tail

After looking for clues to the origin of *panda* it seems quite likely that the word was formed from the Hindu word *bandhu* (since *p* and *b* are often confused in transliteration), and *bandhu* can be traced to the ancient languages of Tamil and Sanskrit as the root-word for cloth "tie-and-dye" patterns – and for our word *ban-*

danna. In this tie-and-dye pattern, bands of undyed tint alternate with the colored ones, the very pattern that shows so plainly on the red panda's raccoon-like tail. Proof of this tie-dye coining may never be found; but it is certainly a very logical explanation, especially when we remember which panda first wore the label.

At any rate, the word *panda* had already been in official European print nearly half a century when Father David discovered the giant-sized black-and-white animal in March 1869. By the time this pelt reached Paris, a real live *wha* from Nepal was on exhibit at the London Zoo – another point in red panda priority. And live red pandas were also first on display in American zoos in 1911, while the first giant panda did not arrive until 1936.

Father David had called his giant a "black-and-white bear," *Ursus melanoleucus,* and that was the label printed with the first announcement of discovery. But after further study, the Paris museum-specialist in charge of official classification, Alphonse Milne-Edwards, recognized anatomical likeness to the red panda, especially in the feet, and so placed the giant in a new genus as *Ailuropoda melanoleuca,* meaning panda-footed (literally, cat-footed) in black-and-white.

Very few systematists agreed with him at the time, and the general public did not agree at all. Everyone went right on calling it a bear – Chinese bear, bamboo bear, harlequin bear. The preferred British term was "parti-colored bear" until 1901, when the director of the London Zoo announced that the official label would be "great panda." American usage eventually changed this to "giant panda," and it was now obvious that the other panda also needed an official distinguishing adjective for an everyday name-tag. Among those already in use were true panda, shining panda, common panda, red panda, and lesser panda, but there has been little agreement about a single choice.

A family likeness

There has also been considerable disagreement about the current placement of both pandas in the family Procyonidae, shared by the raccoon, coati, cacomistle, kinkajou, and olingo. Since the raccoon is the best known of this clan, careless writers have a bad habit of naming the raccoon as the giant's closest kin, not even mentioning the red panda. Actually, the raccoon is not even the closest American relative of the pandas, since all five American procyonids might logically claim the same kinship degree with these two Asian cousins, especially since each is in a different genus. The five American genera are placed together in the sub-family Procyoninae, while the two Asians are in the sub-family Ailurinae. Some zoologists still argue that they do not belong there and that the giant panda, at least, should be in a family of its own, or with the bears. (See "The Making of the Giant Panda," by Joseph A. Davis, *Animal Kingdom,* August, 1972.)

In marking red and giant likenesses, an observer will notice that both have the same flatfoot, toes-in waddling gait. However, the feature that taxonomists mention as diagnostic, or distinctive, is the thumblike, extra digit on each forepaw, which is really an elongation of the wrist bone. In the giant, this oddity is much more pronounced than in the red panda, but for both this thumblike protuberance gives a grasping ability that is almost human.

Both giant and red pandas also have similar teeth, powerful molars adapted for grinding tough winter bamboo growth or, when the occasion arises, for crunching the arms or legs of threatening intruders. Of course the giant's jaws deliver the more powerful bite, if only by reason of superior size. Skull structure, too, is similar in both pandas, and so are the internal organs. Both have an intestinal tract far shorter than that of any other herbi-

The red panda is most active in the morning and evening, so that mid-day zoo visitors usually see it as a ball of fur curled up in a tree, like this one photographed at the Bronx Zoo.

NYZS photo by Bill Meng

vore, suggesting that meat has long been part of the panda diet, in spite of its reputation as a bamboo eater.

Panda diet delights

Perhaps bamboo became the giant's principal food because only the dense bamboo jungles of China's northwest mountains, with their surrounding fortress of rugged crags, deep ravines, fog, and winter snow, gave this slow-moving and unassertive animal the shelter and seclusion it needed for survival. The red panda also seeks the protection of this high country – 5,000 to 12,000 feet and higher – though it has a wider and more varied range, crossing the giant's more northern trail only in the lower reaches of Yunnan and Szechuan. But although bamboo is a favorite food, both pandas have been seen munching on fruits, cereal grasses, and tuberous roots such as iris, crocus, gentian, and various mountain vines. Bird eggs are another frequent food, especially for the red panda, whose lighter weight gives it access to more treetop nests. The first panda in the London Zoo (May to December, 1869) was so fond of a certain yellow berry *(Pyrus vestita)* that it was posed for its official portrait with a tempting clump in curved forepaw.

Acorns and beechnuts are also eaten in the wild, according to Hodgson, whose report published in 1847 is still the most detailed available on red panda behavior outside captivity. Hodgson also added that red pandas are very fond of milk and ghee (clarified butter), and would steal into pantries and dairies of outlying farmhouses looking for this coveted treat. Probably giant pandas are equally fond of this fare, but reports say that they usually head first for the beehives to sample the honey whenever they get near a farmyard.

Several reports from China also claim that both pandas dine freely on insects and small vertebrates – especially birds – but some zoo pandas have refused meat outright. Others have accepted it, and chicken was a favorite treat for London's giant panda Chichi. What captive pandas will or will not eat, however, is not proof of what they eat or reject in the wild. Obviously more field study is needed if the full panda menu is ever to be written.

Panda population puzzle

More study is also needed for an accurate estimate of panda population. Both species are presumably scarce and perhaps always have been. Neither fur has become a staple, though the giant panda pelt makes excellent rugs and sleeping mats, and the red panda skin – like the raccoon's – makes a warm cap. But nevertheless, pandas seem to turn up when people go looking for them, and the red panda has now been found again in Assam, where it has long been thought extinct. Those two gift giant pandas for President Nixon also appeared when the time was right.

Both females normally have two infants at birth (although the giant often has only one and the red has been seen with three or four). Both mothers keep the young with them nearly a year, till another litter is imminent. Gestation takes three to five months for the red panda and a longer seven to nine months for the giant, with the variation within each species probably due to delayed implantation. Normal birth season for the red is early spring, and for the giant late winter, so far as inadequate records show, and there is normally only one litter a year. However, unmated females (and presumably those which lose a first litter) will come into estrus again and again, usually until conception is achieved, and thus a litter may be born at any season. Both pandas rear their young in hollow-tree dens or rocky crevices, but the male giant does not usually accompany the female except at mating time, while the red pandas have been seen in pairs and family groups throughout the year. Both red and giant adults often nap in a tree-crotch high above ground, which the smaller red panda is more likely to climb to greater heights. Both have a musky anal scent gland, apparently used more for marking territory than for sexual identification.

Midday sleepers

Neither hibernates, evidently being well able to withstand severe cold, but they may den up for several days in periods of heavy snowfall. Neither is strictly nocturnal, preferring to sleep at midnight as well as at midday, feeding each morning and evening. Because of the short digestive tract, they require large quantities of food, for little nourishment can be extracted from food passed so quickly through the system. Therefore they are awake and ready for food and play for quite a long time, but unfortunately for zoo-goers, peak visiting hours usually come during the slumber periods – a condition that perhaps can be altered with re-programming techniques.

When it comes to claw structure, red and giant pandas are like neither of their supposed kin, for

The Family Procyonid

▲ CACOMISTLE: Also known as the civet cat, the cacomistle is a fierce hunter. It is found from southern Oregon to Mexico.

OLINGO: Largely arboreal, the olingo runs and leaps with agility. It ranges from Nicaragua to northwestern South America. ▼

COATI: The strongly ringed, tapering tail of the coati is usually carried erect. A forest animal, it extends from the Southwest to Paraguay. ▲

◀ KINKAJOU: Known popularly as the honey bear, the kinkajou is found in forested areas of the tropics. Its most characteristic feature is its long, tapering, and strongly prehensile tail.

RACCOON: Ranging from southern Canada to Panama, the familiar raccoon eats practically any sort of animal or vegetable food. ▼

NYZS photos

An all-American family, the procyonids are small in size, with long tails that are often bushy and sometimes ringed. Whether or not the pandas belong to this family is an open question.

the giant's claws are completely retractable and the red's semi-retractile. Bears and raccoons have fixed claws.

But whatever the likenesses and differences, one point is not contested. The small red-coat was first to carry the panda name and it surely deserves full recognition beside the giant panda in story books, picture books, and zoological annals. It would also be a fitting neighbor for the giant panda in any museum or zoo display – or a substitute for the giant in institutions that cannot as yet obtain the more popular species.

When it comes to naming neighbors, we might also suggest that the Peking Zoo (or any other zoo with giant or red panda on display) should have all the procyonids nearby for comparison – raccoon, coati, cacomistle, kinkajou, and olingo. Scientists may still be disagreeing on their degree of kinship with the pandas a hundred years from now, but there is no question about the similar appeal of round furry faces, clever paws, and prankish ways.

And it also seems fair to suggest that the begrudging label of "lesser" panda be put aside for the "red" panda that is more in keeping with Cuvier's original choice. This little mountain-child fire-fox may be lesser in size but not in charm. And after all, it was the one and only panda for nearly half a century.

SIXTY MILLION BISON

Massacred to the edge of extinction a century ago, the American buffalo now thrives again in huge western reserves.

by G. Earl Chace

A hundred years ago the American bison was hunted to near-extinction. The huge herds that once roamed the central plains, 60 million strong, were reduced to a few hundred. Today, however, the existence of the buffalo is assured. Herds numbering in the thousands once again roam naturally on huge tracts of land. Once more, buffalo meat can be purchased, heads can be mounted, robes can be obtained, and anyone interested enough can see the American buffalo or bison, even if only in state or city zoos.

Considering the carnage that had transpired, it sounds almost unbelievable that for a fee, an ardent, efficient hunter can still shoot a buffalo. But times have changed and the culling out of these beasts is a necessity.

The great western plains are now ribbed with fences holding back meat and dairy-producing cattle from corn and wheat fields. Likewise, the buffalo must also be enclosed. The predators – wolf, puma, and grizzly – are gone and the herds must be kept down to sizes dictated by their food supply, a job that now must be done by man.

The tremendous size of some of the buffalo reserves allows the animals to exist in much the same manner as they have since their beginning, and also gives us an excellent chance to study their habits. The 28,000 acres of Wind Cave National Park in the Black Hills of South Dakota and the adjacent 72,000 acres composing the Custer State Park are excellent examples. Here the herds roam, reproduce, and live much as they did years ago.

Cow leads herd

The main herd is actually composed of many smaller groups or clans led, amazingly enough, by a cow. Apparently the cow's progeny continue to follow her lead and in time, proliferation produces a small interrelated herd. During much of the year the clans spread out and graze by themselves. The fall, however, brings the rutting or breeding season; the clans gather and the main herd forms. The great bulls which have been wandering independent of the herd and clans now gather to test each other's strength and to service as many cows as their polygamous nature and strength permits.

From mid-April to June the calves are born, minus the hump and resembling young cattle rather than bison. Buffalo milk is rich and nutritious, however, and the calves grow fast, being able to keep up with the herd in two weeks and grazing on their own in four to five months. They will weigh 30 to 70 pounds at birth, 300 to 700 pounds within a year, and at three years are close to maturity and 1,100 pounds. The cows can breed at the age of three and normally produce one calf each spring. The bulls continue to grow for nine or ten years.

Custer State Park tries to maintain about 1,450 head of bison, and thus at the fall roundup per-

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G. Earl Chace is curator and lecturer at the Black Hills Reptile Gardens, Rapid City, South Dakota, and has studied the buffalo herds in that state.

NYZS photos

The bison is the largest North American hoofed animal, standing up to six feet at the shoulder.

haps 500 animals will be culled out and disposed of, either by live sale or as buffalo meat. Other than restrictive fences, the only change from a wild state are the mineral and salt blocks spotted throughout the range, and supplementary feed of range cake and hay during heavy snow or drought. Wind Cave National Park's 400 animals are entirely on their own except for occasional salt blocks. Culls from this herd go to the Bureau of Indian Affairs for disposition. Both reserves keep careful check on any disease or parasitic infection and both include elk, deer, pronghorns, and prairie dogs to naturalize the exhibit value.

Never trust a bison

No buffalo, wild or domestic, can be trusted, and so say those who work with them. Although born as gentle as milk cows and often raised with love and care, still, as the bison matures it usually becomes cantankerous. Wild ones have been said to gore, pick up, and carry both a horse and rider for some distance. Park bison have been known, for no apparent reason, to have bashed in visiting vehicles. The character of these new herds seems not to have changed. The known facts of fenced bison match the stories of the wild creatures.

In some of the larger parks, the tourist can now drive through the herds and, by seeing a few head, he may be able to visualize what five million must have looked like. He can also see the old, lone leader, displaced by the energetic, upcoming young bull which finally battled its way to the top. In August, he might even see some of the gargantuan battles for supremacy. In the spring, nine months later, the newborn calf suckling its mother might be photographed – using a telephoto lens. Too close an approach might bring a ring of protective horns, or worse, a mighty charge.

The buffalo wallows are still being made and used, as the animals roll and kick in the center of a large dusty bowl worn into the prairie by such use. Perhaps this behavior provides an insect-proof cover of mud after a rain. The pine trees dotting such an area show typical gloss and polish from constant friction with the rough sides of itchy beasts.

On some days, a visitor might be treated to displays of speed and dexterity of foot as the bison work off excess energy. They may dash across the prairie as fast as a horse can run, or stop and wheel with the lightness of a working quarter horse or polo pony.

Survivor of the ice ages

The species is the survivor of ancient ice ages, and is called, appropriately enough, *Bison bison* by the taxonomists. Ever since its discovery, the bison

Young and adult bison enjoy a wallow in the dust, even on the "prairie" at the Bronx Zoo.

has had tremendous influence on the history of this country. The animal was first seen by the Europeans in what is now Mexico City. Cortez saw one in Montezuma's zoo when the Spanish explorers arrived there in the early 1500s. The Spaniards called these new animals "humped-back cattle." Later, when the first settlers arrived, they began to call them "buffalo" after the unrelated Asian water buffalo.

The original settlers in this country could not possibly imagine the enormous numbers of buffalo to be found on the western ranges. Estimates were from a couple of million to as high as hundreds of million. It took many years of careful study to arrive at the considered figure of 60,000,000 individuals during their prime days. This is more animals of such size ever found in any country in all history.

The bison is a huge and stately beast. Modern males have surpassed a ton in weight. It is a grazing animal, living basically on grass and, when full, lying down to peacefully chew its cud. Its size, weight, and apparent peacefulness belie its ability. The bison can be extremely fast, unpredictable, and murderous. Its weight, concentrated in the forequarters, makes it a perfect battering ram. Its muscular but lighter hind quarters give it agility, speed, and endurance. If nature had also endowed the buffalo with greater intelligance and better eyesight, nothing could have withstood it.

The male American bison is a cloven-hoofed ungulate, standing about six feet at the shoulders and reaching perhaps eleven feet in length. It averages about 1800 to 2200 pounds in weight. The females are a little smaller. Elongated dorsal vertebrae generously padded with muscle give it the appearance of having an irresistible potential in battle, which in fact it has.

Wolf, grizzly were predators

For thousands of years these animals roamed the great prairies of North America. They penetrated the forested eastern states, climbed the lower mountains of the west, and tested the edges of the deserts. Their only animal foes were the wolf packs, which trailed the herds in hopes of bringing down the old and weak or an occasional straying calf. Should wolves threaten, an innate herd instinct normally brought a ring of lowered heads and horns around a frightened bawling calf and its mother. Perhaps the only American predators with the nerve or ability to successfully cope with an adult buffalo were the mountain lion and the large brown grizzly bear, and even they were but partially successful.

A far greater hazard to the herds was nature itself. Long dry spells and intense heat sometimes all but killed the buffalo grass or sucked the acces-

sible waterholes dry. Buffalo grass, mainstay of the bison, was tough enough to withstand the millions of hoofs and hungry mouths, replenishing itself after the animals passed. But it too, succumbed during total drought.

Winter's cold was less of a problem to the bison which, unlike cattle, faced the winds. Long, warm, heavy hair protected face, head, and shoulders from all but the worst blizzards. Lack of good eyesight during severe storms often cost some bison their lives. Partially blinded by flying snow, buffeted by high, cold winds, and undoubtedly seeking shelter, they would walk slowly into the wind and over a cliff.

Normal snow depths were brushed aside by the animals with their muzzles to reach winter grasses beneath. Tremendous power in a massive body enabled them to force their way through man-trapping snow to reach shallow snow where they could graze. Only the worst blizzards stopped and killed them, if caught in tree-lined gullies where the snow backed to depths well over their heads.

Threats of ice and fire

The coming of spring sometimes exacted a terrible toll from herds. Normally, buffalos separated into hundreds of small herds or family groups, scattered over many miles of prairie. A blizzard or drought, although harsh on a few, did not generally effect the overall population. In the spring when the groups combined for breeding purposes or began a mass food migration, adverse conditions were magnified. Small groups successfully crossed and recrossed winter's ice-covered rivers many times. But when spring weather melted and weakened the ice, the river surface would give way under the weight of the animals and tremendous numbers of buffalo were drowned.

Summer storms also created havoc with a large herd. Thirsty prairies and dry grasses would be struck by lightning before the rains fell to wet them down. The resulting fires would race before the stormy winds, frightening the bison and sending thousands of terrified animals in a mad gallop across the prairies. The slow, old, or young were often trampled by the rush or burned by the flames.

Still, natural conditions and predators had but nominal effect upon the great bison herds. For thousands of years their hoofs loosened the topsoil so rain could seep in, and their droppings fertilized it. Their dead fed the vulture, crow, magpie, coyote, and many smaller scavengers, and their numbers increased until their grazing grounds could no longer feed them. In solid masses, some said to be 50 miles long and 20 miles wide, they migrated across the prairie to new grazing grounds, and the earth trembled with their passing. Years later, the caravans of westward-bound settlers followed the same trails already blazed by the buffalo over the prairies and through the mountains.

During this time a human culture developed around the buffalo. Although deer, antelope, and elk existed for the Indian to hunt, it was the buffalo that wore the warmest coat and carried the most meat. Also, their large numbers ranged over a greater territory than other animals. Bison then roamed from Canada south to Mexico and almost from coast to coast.

For centuries it was hunted, first with clubs and stones, then with spears. It was a tremendous undertaking for the Indian to approach a beast

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The Buffalo-Indian Head nickel, first minted in 1913, was sculptor James Earle Fraser's most popular creation. The work was commissioned in 1911 by the Secretary of the Treasury, Franklin MacVeigh, to replace the liberty head nickel.

"In designing the Buffalo nickel," Fraser recalled, "my first object was to produce a coin which was truly American, and that could not be confused with the currency of any other country. I made sure, therefore, to use none of the attributes that other nations had used in the past. And, in my search for symbols, I found no motif within the boundaries of the United States so distinctive as the American buffalo or bison. The great herds of buffalo that roamed over the Western plains played an important role in winning the West.

"With the Indian Head on the obverse, we had perfect unity in theme. It has a pertinent historical significiance, and is in line with the best tradition of coin design, where the purpose was to memorialize a nation of a people."

Commenting on the buffalo used, Fraser said, "He was not a plains buffalo, but none other than Black Diamond, the contrariest animal in the Bronx Park Zoo. I stood for hours watching and catching his form and mood in plastic clay. Black Diamond was less conscious of the honor being conferred on him than of the annoyance which he suffered from insistent gazing upon him. He refused point blank to permit me to get side views of him, and stubbornly showed his front face most of the time!" (Although Fraser did work at the Bronx Zoo, there is no record of an animal named "Black Diamond" at the Zoo. *Ed.*)

afoot at close range so that he could bring the creature down with primitive weapons. A more effective but wasteful way was eventually found. Herds were somehow stampeded toward the edges of high cliffs or sink holes, where the pressure of frightened, fleeing bison would force the front lines over the edge. This procedure employed many men, each of whom later took what he could carry from the carnage below.

Everything but the snort

Every part of the animal had its use. Much of the meat was dried into lightweight, concentrated, nourishing jerky, or mixed with berries and fat to form pemmican. The skins were used for robes, blankets, and shelters. The sinews were saved for bow strings or thread, and thin belly strips were cut into rawhide which could be braided into rope. Hoofs were processed into a glue, long hairs woven into cloth or decorations, and the outer shell covering of the horns was boiled and shaped into spoons and other utensils. Entrails were often used as water bags.

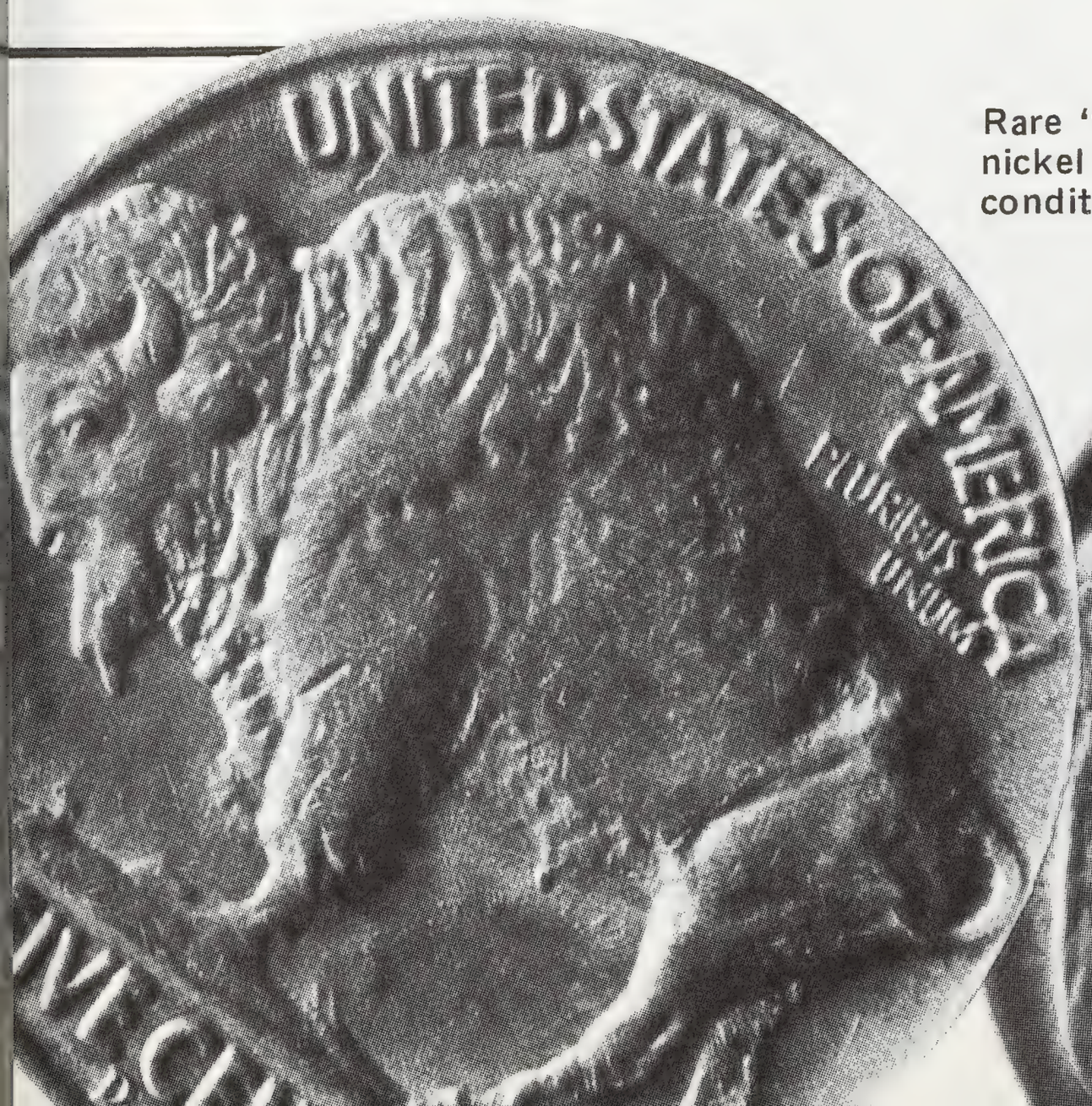
When the Spaniards came, they brought a new aid to the Indian buffalo hunters — the horse. These were put to use as fast as the Indian could find, steal, or raise them, and buffalo hunting by the Indian became more efficient. The early European settlers in the New World had been living mainly on deer, turkey, or bear meat, and then buffalo meat was discovered. The change of diet was welcomed and the addition of the warm hides doubled their pleasure.

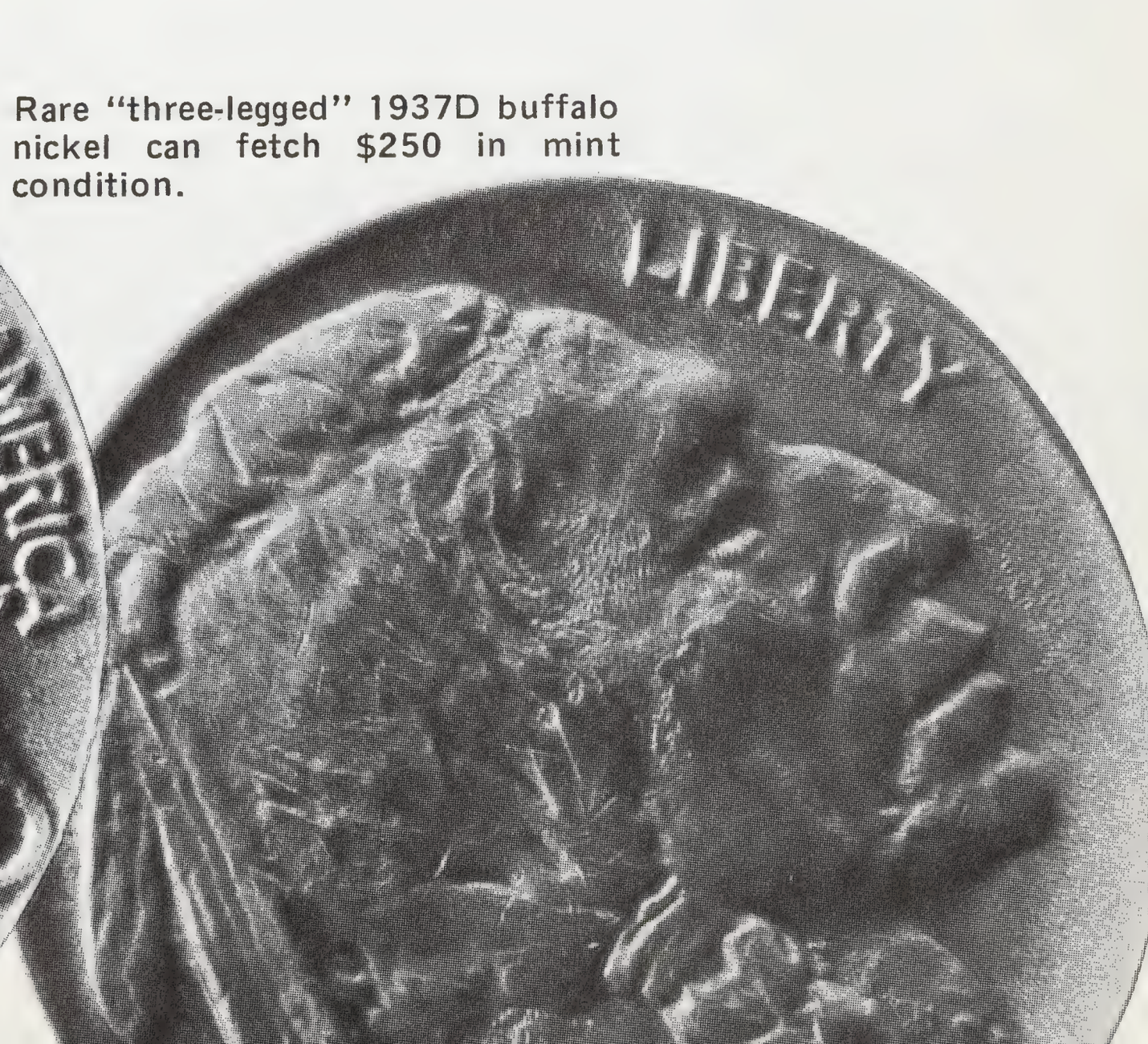
Buffalo are essentially creatures of the wide open areas. The deciduous forests of the eastern states did not provide sufficient grass lands for extensive herds, yet bison had penetrated into many of these states in limited numbers. There have been authorities who claimed a forest species as well as a plains species, and also a northern or mountain species. Most authorities today believe there to be one species, slightly altered by time and a different environment into subspecies. The settlers made short work of the buffalo they found and according to one historian, the last wild buffalo east of the Mississippi was shot in 1883.

By this time the trappers, explorers, and adventurers had traveled far to the west and many had returned with stories of more bison, so numerous that the birds could hardly find a place to land. They spoke of land stretching from horizon to horizon, all black with bison. Hunters began to travel west and send back hides and meat. But it remained for the first transcontinental railroad, then under construction, to really trigger the great buffalo hunts. No sooner did the rails reach out from civilization onto the sparsely settled west than the logistics of supply at the railheads forced an issue. Hundreds of men at the ends of the track needed food and it was easy to shoot the buffalo, on location, for its meat. The buffalo lost.

Buffalo tongue a delicacy

The returning trains hauled hides and meat, increasing eastern demand, and the hunters went west in droves to satisfy this need. As the buffalo traffic grew, specialization set in. Head hunters killed to have the heads mounted. Tongue hunters supplied those who craved this delicacy. Hide hunters took only hides, and one group of gourmets sought only the hump from the shoulder of the otherwise wasted bison. One man actually set





Rare "three-legged" 1937D buffalo nickel can fetch $250 in mint condition.

For hundreds of years, Indians hunted the buffalo by driving the herds over the edge of a sink hole. Excavation of one hole near Beulah, Wyoming, by a team from the University of Wyoming, has exposed an accumulation of bones approximately 80 feet long and 14 feet thick.

up a factory for weaving the long hairs from the buffalo forequarters, but this proved too difficult and failed.

Each specialist shot, killed, retrieved his portion, and left the rest. A few shot for fun, taking nothing. Others operated train excursions and sponsored contests to see who could "pot" the most bison in a given time or with the least expenditure of bullets. It took about 80 years to clear the prairies of buffalo and substitute a vast sea of bones. Wolves and coyotes prospered as never before on the spoils.

It also cost the world a culture. For centuries the Indians' survival had depended on the buffalo. The Indian Wars had been waged for possession of land, for a way of life, and finally for life itself, as the Indian saw his only source of supply dwindle and finally disappear. True, a few Indians aided the slaughter in trade for knives, guns, ammunition, blankets, or whiskey, but these possessions could not forestall the end of his way of life.

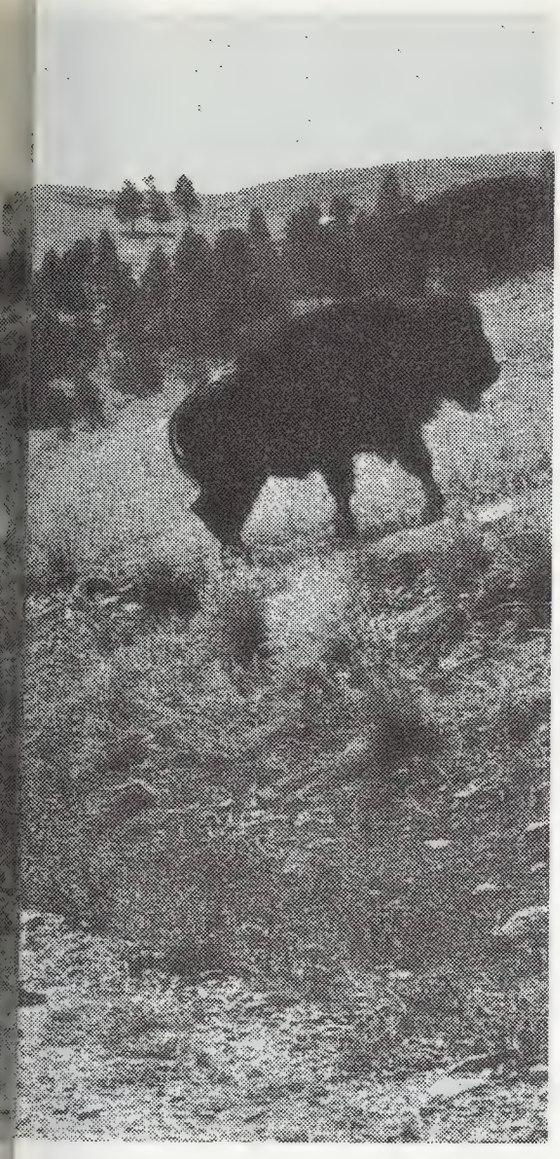
Our government, knowing well what was going on, did little to halt the massacre. Its effect on slowing the Indian Wars was more important than the buffalo, and it worked. Removing food, shelter, and sustenance from the prairie forced the Indian onto reservations and dependency upon government allotments and rations. The war, for the most part, was over.

The buffalo lost. The Indian lost. The white man lost. Sixty million buffalo were gone. An immense environment changed. A whole culture was lost. Untold numbers of people were dead and several Indian nations were reduced to complete dependency.

Resurrection of the bison

In the late 1850s, there were but few bison remaining in the United States, only 541 according to Dr. William T. Hornaday, then of the National Museum in Washington, D.C. The plains, however, were covered with skeletons which enriched a few entrepreneurs. Collected and shipped east, the bones were ground up for fertilizer or burned for their carbon.

In 1886 Dr. Hornaday did not have a single representative of the by then nearly extinct bison. With great effort, he managed to obtain some wild specimens. Next year, the American Museum of Natural History in New York City attempted the same task and failed. They had to buy theirs from private herds which a few thinking people had established. The only buffalo left in North America at the time were a few privately



Driving through Wind Cave National Park or Custer State Park in South Dakota, the visitor may observe buffalo crossing the road. Needless to say, the animals have the right of way.

owned animals, a few in Yellowstone Park under "loose" protection, and another small herd that had wandered into Canada and was under that government's protection.

This spurred Dr. Hornaday, who had become director of the New York Zoological Society, to write articles and letters which aroused much of America to the necessity and humaneness of saving the bison from complete extinction. The New York Zoological Society had acquired the nucleus of a herd, and in 1905 the American Bison Society was formed with President Theodore Roosevelt as Honorary President and Dr. Hornaday as active President. Dr. Hornaday proposed stocking the game reserve of Wichita, Oklahoma, with buffalo and the purchase and establishment of more ranges of a like nature. The proposals were accepted by the government and in 1907 the Bronx Zoo sent 15 buffalo to Wichita as a successful experiment.

Following this success came the Montana Bison Range, then the Niobrara Reservation in Nebraska, and the Wind Cave herd of South Dakota which was stocked by bison from the Bronx Zoo in 1913. Since then, many states have acquired sanctuary lands and bison. Canada has more than done her part, maintaining the largest of existing herds in the immense 17,300 square-mile Wood Buffalo National Park.

The buffalo is now honored throughout the land. Towns, cities, and parks have been named after it. In 1901, a ten-dollar bill had a buffalo engraved on it. In 1913, the five-cent piece, or nickel, was issued with a buffalo on one side and the head of an Indian on the other, and in 1933 a 30-cent stamp had a buffalo on its face.

North America has tried its best to make amends to perhaps the greatest animal of its realm by insuring its survival for the future.

A herd of bison grazes on the western plains of a protected reserve, a remnant of the vast numbers that once roamed North America from western New York State to the Rocky Mountains.

Photos by G. Earl Chace

Photos by Simon Dresner

Herds of English fallow deer and llamas can be petted and fed in the animal contact areas. The hand-raised animals are very tame and are fed most of the day's food before opening time, so that they seek only tidbits.

The eland bull doesn't like Roland Lindemann. Every time the stocky owner of the Catskill Game Farm comes near, the animal separates itself from the peacefully grazing herd. Head slightly lowered, spiral horns at the ready, it turns a baleful glare on Lindemann, and its eyes never leave him until he moves out of the area.

The secret of the eland's animosity has yet to be solved. "I never touched the animal." Lindemann protests, interested, amused, but perhaps also faintly hurt, because the Catskill Game Farm was created out of, and is still animated by, his immense love of animals. Lindemann himself is a jovial person, easily likeable by beast and man. In his mid-sixties, he is fond of telling stories about his adventures and misadventures in the animal world.

Barbara and Sy Ribakove are a husband-and-wife writing team who specialize in interviewing personalities. Their avocation is the training and breeding of show dogs.

To the average visitor his "farm" in Catskill, New York, is a pleasant country place to bring children for a day of viewing, petting, and feeding animals. But the Catskill Game Farm also houses an extensive collection of horned and hoofed animals. It is a supplier of rare deer and horses to zoos throughout the western world. And on its 170 exhibition acres and 1,100 back acres, Lindemann and his dedicated staff have enjoyed singular success in coaxing rare and delicate animals to thrive and reproduce.

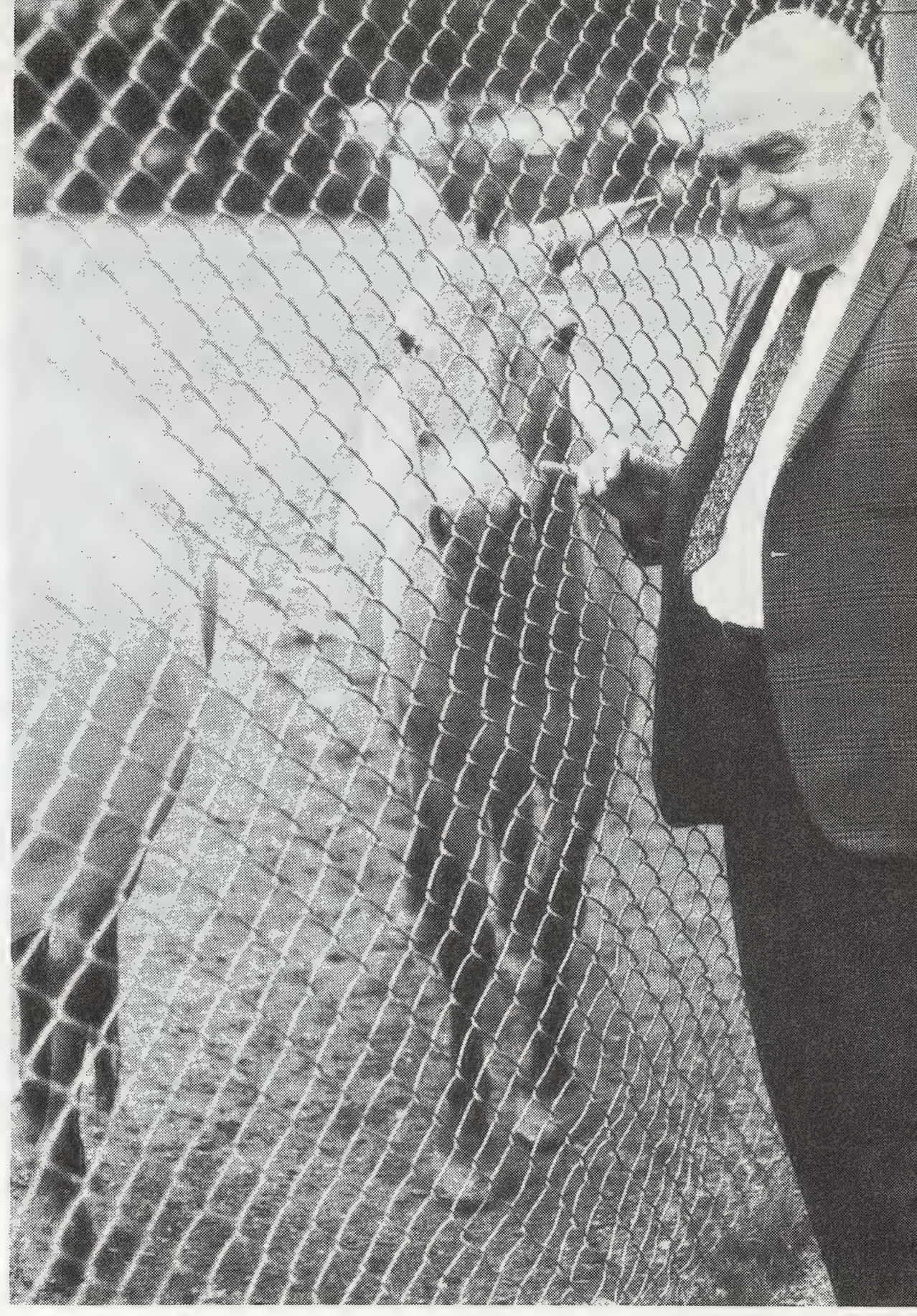
Lindemann puts in a 15-hour day. His notion of retirement would be to camp in the mountains of Tibet and capture breeding specimens of the kiang (wild ass) and the high-altitude chiru antelope, both of which his collection still lacks. Only former U.S. Government strictures against traveling in China have stopped Lindemann from setting out on the expensive and hazardous expedition in the past.

The placid looking Watusi cattle on display at the farm were acquired through Lindemann's most determined efforts. Although a common dairy ani-

HORNS AND HOOFS IN THE CATSKILLS

The Catskill Game Farm is a collector's showcase of horned and hoofed animals from all parts of the world.

by Barbara and Sy Ribakove



Roland Lindemann, founder and owner of the game farm, personally knows many of the farm's 2,000 animals.

mal in Africa, Watusi cattle are unknown in American zoos because government health regulations forbid the importation of domestic animals that may carry disease germs. But the mere existence of Watusi cattle was enough to trigger his collector's urge.

Detour for Watusi cattle

"I went to Washington," he says in the Teutonic accent and turn-of-phrase that belie his nearly 50 years in the United States, "and I told them, 'I must have Watusi cattle, I will know no rest until I get them.' So the people in charge explained to me how this could be accomplished. 'First you must manage to get them from Africa into Germany. Then you have to get them out of Germany into Denmark. Then you must keep them in Sweden until the young are born, and after 60 days, you may bring the young here.' "

This unwieldy itinerary might have discouraged anyone else; Lindemann seized it gratefully. "You see," he explains, "no domestic animals can be imported here ever unless they come from a country completely free of certain diseases. That means only Ireland, Norway, and Sweden. Norway and Ireland don't let anything come into *them.* Sweden will let in animals only if they have been quarantined six months in Denmark, and Denmark will let in what comes from quarantine in Germany. Sven Andersen, director of the Copenhagen Zoo, finally obtained Watusi cattle and in due time assisted in getting them to Sweden. It took me four-and-one-half years to bring in my cattle because when they finally gave birth in Sweden, both calves were bulls and I had to wait another year for heifers, from another source. Now I have a small herd, and I am happy. Those first Watusi cattle were rather expensive. You see, when I was young, I knew that to do this sort of thing, I would need substantial capital."

Lindemann was 12 when he decided on animal collecting as his life work. Even as a school boy, animals were familiar to him; he knew the great Berlin Zoo as intimately as his own home, and had a small collection of wild pets, including a llama. He was a frequent visitor to a small menagerie in Germany, whose owner sat in a booth collecting what the youngster regarded as a vast sum of money for tickets and animal food. These experiences molded his future. As he recalls, he approached his father and said: " 'I'm going to have a zoo when I grow up.' My father wanted me to be a doctor and so he spoke to me only in Latin, and in Latin he told me I would *not*. But I knew better."

In his teens, young Lindemann began to understand that animals not only earned money but cost

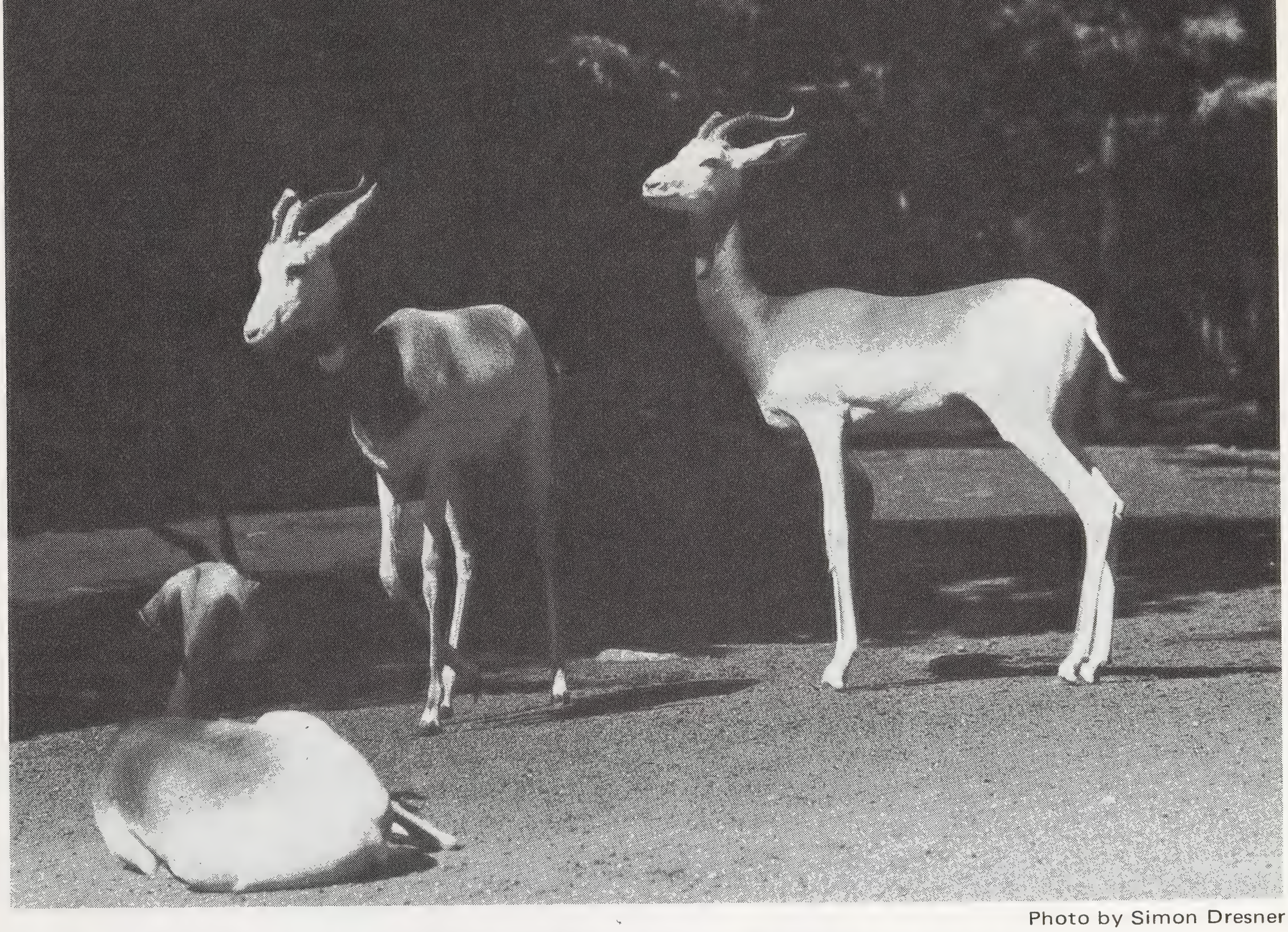


Photo by Simon Dresner

Graceful dama gazelles, with their brilliant white coat, stand out sharply against the dark foliage.

money, and he emigrated to America to make his fortune. Relatives sent him to school to study industrial banking, then in its infancy in the United States. In his early twenties he helped set up the first small loan companies in this country. By the time he was 25, he was in New York City, training other future financiers, and holding an interest in a prosperous fiscal agency. He was a wealthy man before he was 30. But Lindemann has always regarded his wealth only as the means to an end.

"When I was in business, every spare minute I lived in a zoo – Bronx Park, Central Park, and in other cities where I traveled. I knew the stock and inventory of every major zoo better than anyone. The hoofed and horned animals especially, they have always been my favorites since boyhood.

A hobby turned vocation

"In 1932 I bought this farm in the Catskills, and as soon as I could I left business altogether to devote myself to animals." Lindemann fenced his first hundred acres, built his pens and houses, and hired local dairy men to look after the antelope, deer, and rare pheasants he began to collect, two or three at a time, as money and opportunity permitted. From 1933 to 1940, his farm was open to the public without charge.

For several years he and the Berlin Zoo competed for top honors in the deer field. "It was the most nearly complete collection of deer in the world neck to neck with the Berlin Zoo. When I had 26 species, they had 27. When I went to get the 27th, they would get the 28th. But at the 28th species, we both got stuck – we couldn't find any more."

Lindemann kept the farm going during the lean years of World War II, when gasoline rationing severely cut the number of visitors. After the war, with his finances depleted, he decided to make the farm a commercially self-sufficient venture, complete with restaurant and comfort stations. Local bankers, to whom he applied for improvement loans, were openly skeptical. Who, the bankers demanded, would drive over dirt roads to a place scarcely on the map just to look at animals – and non-carnivorous animals at that? Lindemann saw it differently, applied his business expertise to the question of how many tourists might be attracted to spend how much on what, took his figures to a city bank, and got his money. Today the Catskill Game Farm yields a profit from the more than half a million people who visit from April 5th to November 15th.

After World War II, Lindemann's attitude

toward the game farm changed somewhat. Originally a private passion, it now took on a deeper significance. "I began to see the need for conservation. I came to the conclusion that in 10 or 15 years, we wouldn't be able to get certain animals in this country, it would be prohibited to take them out of their natural habitat. Now the main purpose of the game farm is the preservation of wild animals for the next generation. If we do not do this, if zoos do not do this – if we are only interested in exhibiting an animal and pay no attention to breeding – then the next generation will go into a museum to see stuffed animals, and maybe their fathers and grandfathers will say to them, 'Well, I saw this animal still alive.' We must remember that if wildlife goes completely, eventually we will go, too."

Breeding Przewalski horses

The effort to save threatened species and maintain rare animals in a sometimes uncongenial climate has involved Lindemann and the game farm in numerous adventures. Many of these condern his unique breeding herd of Przewalski horses. These ancient creatures have remained unchanged by evolution since prehistoric times. Today they are virtually extinct; of the 180 known to exist, 53 have been raised at the Catskill Game Farm.

"The entire area where these horses originally existed," Lindemann explains, "is only about 50, 60 miles long, a valley with a stream in the center which divides China from Mongolia. The Russian Czars sent some expeditions to bring horses out, but without success. Finally in 1901, 28 colts were brought out and later one more, plus some hybrids from matings with Mongolian ponies. Eight of the purebreds were in the Munich Zoo, and during World War II they were hidden with local farmers while the hybrids were on display. After the war the purebred Przewalskis came out from the farms and the stables, and Heinz Heck, director of the Munich Zoo, built up the herd to 14.

"In 1956, Heinz Heck flew to America and offered American zoos half of the existing herd. Do you know, not a single zoo could see what it meant to obtain overnight a breeding herd of these rare animals? I left with him the same night for Germany, and we built crates, day and night, and we put the horses on a railroad, and I bought eight, from which we have now raised 53."

The mating of Przewalski horses is not a sight for the general public to view with equanimity. "The first time I saw it," Lindemann says, "I thought, this is unbelievable. I had seen Somali wild asses and onagers mate, and they were violent, but nothing like this. It's terrific, they take chunks out of each other, they bite the necks, mutilate each other – the first time I saw it I thought everything was going to pieces, the fences were going down, the house was going down – I rushed to the telephone and called Heinz Heck and said, 'My God, what must I do, they will kill each other!' He said, 'Calm yourself. When Przewalski horses are bred, blood must flow!' "

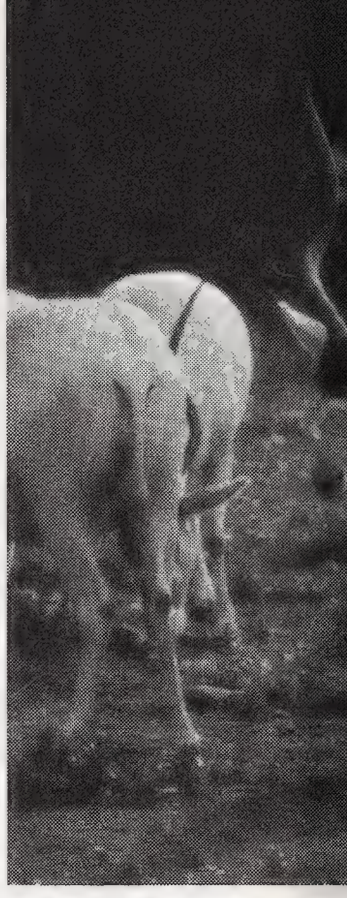
A Przewalski mare comes into season a mere nine days after giving birth. Most of the specimens – ungainly horses to the layman but beautiful to a zoologist – are thoroughly scarred. "But we spray them with oil, and they heal up very quickly," says Lindemann, who is now expert on the breed.

The Przewalskis surprised Lindemann by the ease with which they adapted to life on his farm, and the readiness (by their own strenuous standards) with which they bred, enabling him not only to increase his own herd but to sell animals to every major zoo in America. He attributes his suc-

The cinammon-colored springboks were named after their habit of leaping ten feet into the air when startled. Herds numbering over a million once migrated across Africa, but today the animals are very rare.

Photo by William G. Conway

The Himalayan tahr's shaggy mane protects it against the cold of its native habitat — the tree-covered mountain slopes of Nepal and Sikkim. They are skillful climbers.



A herd of addax thrives at the game farm. The remoteness of their native habitat — the Sahara desert — has protected the species.

cess to the careful watch kept over the horses and the confinement of the breeding herd to two-, three-, and four-acre pens rather than to vast open tracts.

Deer survival problems

Another significant factor may be Lindemann's ability to sequester shy, nervous, hard-to-maintain animals in areas only he and his highly-trained keepers ever penetrate. The farm provides ample seclusion for such species as Siberian roe deer, which are easily upset by public attention. There are also exercise and breeding pens to which animals that are on public display are frequently transferred.

Among Lindemann's major successes, American mule deer rank high. "No zoo east of the Mississippi or in Europe could keep mule deer alive. I was determined. Twenty-eight years I battled, losing animals continuously. Finally I captured some females that were already pregnant. I brought them here, they gave birth. The mothers died after 60 days, but of the young born here, one out of every three adapted and survived. Trying again and again I finally built up a group of eight animals and from these eight, *all* the mule deer in eastern and European zoos now stem.

"Humidity is a great factor. So is diet. We have in Catskill one of the few roan antelope groups in the world; I lost more than half of them before they became acclimated and accustomed to the diet. Now we have enough roan antelope to sell to zoos. When we get a new species, I try to determine the particular substances, the protein values, the calcium values of the vegetation where they live, and duplicate them as far as possible."

Not all the game farm's efforts have proved successful. Ten attempts to keep bighorn sheep — the emblem of the New York Zoological Society — have failed, because of the humidity problem, Lindemann believes. Animals from high plateaus develop lung adhesions when kept in low altitude zoos where the humidity is higher, says Lindemann. All seven of the musk oxen born on the farm died before they were ten months old. And though Lindemann has succeeded in raising a moose or two, they are, he says, "nothing to brag about."

What he does brag about is his staff. Besides his top men — Dr. Heinz Heck (nephew of the famed Munich director) and Jurgen Schultz, his son-in-law, a fourth-generation animal-man from Southwest Africa — there are 50 full-time keepers whom Lindemann has personally trained. "It's a matter of pride that we are a training ground," says Lindemann, "and that my men spend two months on each different animal learning its diet, its diseases, its habits, its dangers, and attend my weekly lectures. Some have gone on to become keepers and curators in great zoos."

Meeting the animals

Much of the commercial success of the Catskill Game Farm is due to the two animal-people contact areas, where whole herds of English fallow deer and llamas can be petted and fed. "When I started this it was unheard of here, and every professional told me it would not work, the animals

Photos by William G. Conway

would be hurt. I did not think so. I knew it would attract visitors, and when we first went commercial in 1945, it was the feeding area that supported the whole farm. The animals are fed 60 per cent of their day's requirement before opening time, so they look only for tidbits – and we allow only the special food we sell to be fed to them. No one ever injures an animal. Many zoos and exhibitors have now adopted the idea."

An amazing number of the farm's more than 2,000 animals are known to Lindemann personally. He has had his special pets – a llama named Patsy which followed him like a puppy; a white-tailed deer named May – and his enemies: remember that belligerent eland? There are several mysteries Lindemann intends to solve: why does the eland distrust him, why does one zebra persistently attempt to attack Dr. Heck, why does a particular buck have to have its horns tipped with brass balls to keep it from goring an inoffensive keeper? "Is it the scent, the appearance, the personality?" Lindemann muses. "Something, but what?"

Mysteries are troublesome to Lindemann because he is a man who likes to know exactly how many pounds of feed each species consumes daily, how many brushes and cans of turpentine are stored in the maintainance closets; he can tell at a glance the age of every tree the farm grows in its own nursery; and when asked how many animals inhabit the public feeding grounds, he promptly replies, "Sixty llamas and about 267 deer." When Lindemann says "about," he means, "precisely."

Horses in the wild

One day he would like to turn the management of the farm over to his staff in order to have time for some far-ranging projects. Besides the much-anticipated kiang and chiru expedition to Tibet, there are a dozen much-wanted Somali wild asses waiting in a corral in the Danicol Desert in Ethiopia, captured at great trouble and expense in 107

Blackbucks, native to the plains of India, take great leaps when alarmed. They are so fleet that only a cheetah can catch them.

degree heat. Unless Lindemann comes up with a minor miracle, soon they will have to be transported to Ethiopian Emperor Haile Selassie's personal game preserve rather than to Catskill, New York, where Lindemann needs them to bring new blood to his present herd. The problem is that 11 out of the 12 asses show a positive blood factor for piroplasmosis, an African horse disease. Only one animal tests negative and can be admitted to the United States. And even Roland Lindemann, who spends some $300,000 a year for new animals and improvements, thinks the minimum air freight charge of $28,000 is a little steep for bringing in one Somali ass.

There are also two still-unrealized major dreams. Lindemann would like the personal satisfaction of having a complete collection of every living horned and hoofed species, all thriving and breeding contentedly on his premises. The other dream may be more difficult to achieve. "Among all the animals I love, I have perhaps always been most interested in equines – not domestic horses which are human creations, but wild ones. I think my greatest satisfaction would be if we could take some of these endangered species, like the Przewalski horses, and introduce them once again to the wild, so that someday people could visit a national park with 500 or 1,000 horses living there."

Tracking the Mouflon of Corsica

An amateur naturalist tackles the rugged mountains of Corsica in search of the island's elusive wild sheep.

by Walter H. Kilham, Jr.

Of the family of wild sheep, the mouflon of Corsica, *Ovis ammon musimon,* can hardly be considered an "endangered" species. Outside of their original habitat, the islands of the Mediterranean, there are now some 20,000 of these sheep in zoos, preserves, and even running wild, from Finland to New Zealand. The Bronx Zoo has had a small herd of mouflon, 41 at the moment, ever since the first pair of animals was acquired in 1906.

It is said that on Corsica perhaps 200 remain, a hundred or so in the region of Bavella, where there is a forest reserve of some 2,700 acres. In early January 1971, I had a chance to cross over from Spain to Corsica, which gave me the opportunity to visit the mouflon in its native habitat.

Late one afternoon, I reached the little mountain town of Zonza. I quickly learned that not only was the road blocked by ice and snow, but the hamlet of Bavella, where I had intended to stay, was deserted for the winter. By good fortune, however, the local Garde Forestier lived in town. He brought me up to date on the ways of the local mountain sheep, and advised me on an alternate route over the mountains.

Early the next morning I was on my way. By noontime, I reached the two-story granite shelter of the Forest Service, which fortunately had one room with a little open fireplace where I was to camp out. From my eyrie under the stand of magnificent Lariscio pines that shaded the terrace, the valley of San Pietro dropped off steeply to the northeast. Its upper slopes to my left terminated in abrupt cliffs and serrated pinacles of red granite making a jagged profile against the sky.

A rugged habitat

It was on the slope across the valley to the right, below the snow, that I would expect to find the mouflon at this season. It was a spot at once remote, wild, and above all silent, a striking habitat for this last retreat of the wild sheep of Corsica.

Below the almost vertical peaks and cliffs at the top side of the valley were the usual talus slopes. Not far down, scattered vegetation began and then a dense cover of shrubs and small trees that provided good cover for the mouflon.

When first observing a new country for animals, it is sometimes difficult to judge the scale. It's a question of whether one should be looking for something that will look big as a cow against small cover or as small as a rabbit against large. Then again, with a new animal, one is not sure what tell-tale mark to be looking for when it stands motionless in the underbrush. As the old saying goes, "The first thing I see'd, I didn't see nothing."

Then, all of a sudden, I did see something, more unusual, in fact, than I had expected – for it was the gerenuk that flashed to mind. There, standing on its hind legs nibbling the top leaves of a small tree, just like an African gerenuk, except that the neck was too short, was my first mouflon.

Wild sheep are usually thought of as creatures of the high open spaces, above timberlines. The mouflon of Corsica, however, were originally creatures of the woods, ranging from sea level up, for the island was originally heavily forested, characteristically with evergreen oaks. They are still at home in the protective forest cover, where other wild sheep tend to seek security in inaccessible open spaces with a clear view.

Some time had now passed and more sheep came into view. Wild sheep have keen eyesight and my approach on the opposite slope had doubtless been observed by the mouflon, well concealed in the cover. Having remained motionless myself long enough to reassure them, they had now begun moving about. Five came in sight crossing an open space, one a ram with a full set of horns.

Walter H. Kilham, Jr., has tracked wild sheep from Afghanistan to Alaska, where he participated in a government survey of dall sheep in the Mackenzie Mountains.

Graphic by William

W. D. BERRY
'72

The tell-tale mark in the brush was the white rump divided by the black line of the tail. One of them emphasized another feature, a white face. As these sheep get older, the area of white on the face increases from the nose upwards and it makes a good eyecatcher to watch for when they are motionless in the bush and otherwise well camouflaged. When I would shift my glance to a new sheep, the first would disappear when I looked back. It was important, therefore to note some landmark near any one sheep to which the eye could return. Evidently, one reason for the survival of these sheep in Corsica was the excellent concealment provided by the particular terrain. As it got cold and dark, the sheep were moved up their side of the mountain, so I went back up mine.

The next day, I was up long before dawn and back at the lookout point by daylight. It was not long before the movement of sheep was noticed – two crossing the mid-slope. Then a group of seven came down from high on the mountain. With this assurance that the mouflon were there, I made ready to cross over the valley and try to get near enough for some pictures. The lower slopes were terraced along the contours, which meant I would be in plain sight as I crossed them. I was wide open to observation and high above I could see the head of seven sheep watching me.

I may have approached within 400 yards when they all crossed some open ledges and disappeared. I now climbed up through a jumble of huge boulders until I was back of the ledge. Here the typical ground cover began where I had seen the mouflon the night before. The brush was high enough to hide a sheep, but in general it was low enough so I could see above it. In other words, they could always stay out of sight while I would always be in view.

Evergreens provide food

The area I was now entering was in the winter range of the sheep and below the snow line of the storm. The shrubs or small trees were largely evergreen, providing the principal source of food for the mouflon, particularly in winter. Of these the *arbousier (Euonymous),* translated as "strawberry bush," seems the most important. The leaves at the outer end of the branches are more tender, which may account for the habit of the mouflon of standing on its hind legs to reach them. The *chene-vert (Ilex)* was another common evergreen providing forage. Available too were the dried leaves of the various bushes such as laburnum and brambles. Underfoot the soil was gravelly, good sheep habitat, with various dried grasses and plants.

There are no longer any predators as such but the pressure from poachers never ceases. The huge boulders, narrow ravines, and broken-up ledges, mixed in with whatever shrubbery that can grow among tham, all provided natural protection. This last resort of the mouflon seemed an ideal fortress where they could be safe.

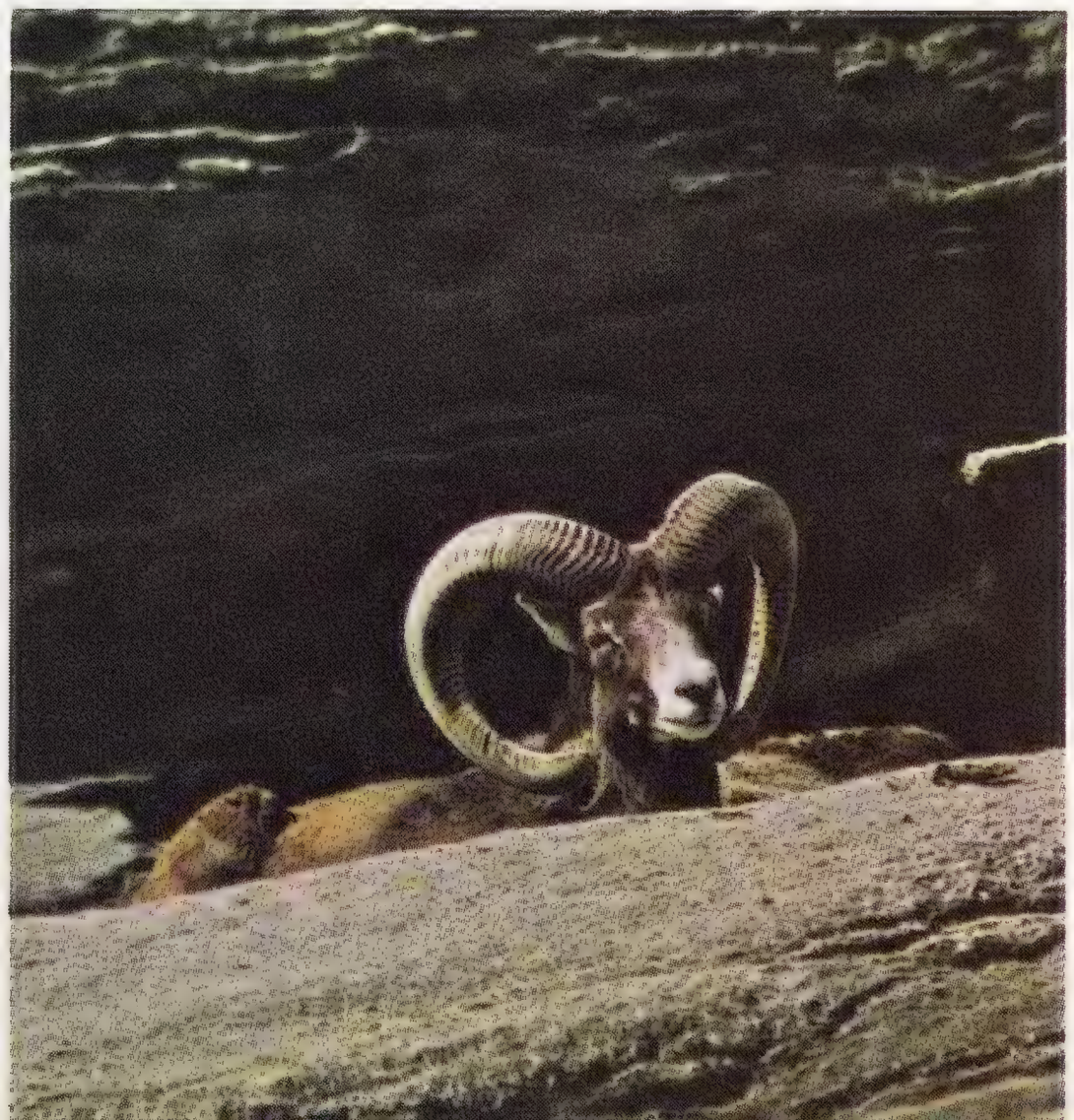
The present restricted habitat is but a minute fraction of the original range of the mouflon on this island. We can hardly expect, therefore, to find seasonal migrations as may be the case with sheep in other parts of the world.

Continuing on my way, I failed to notice a large ram a short distance above them in the undergrowth. When it became aware of my presence, it climbed out on one of the big boulders for a better view. It is this exposure, when the unknown is a poacher, that provides the hunter's opportunity for the fatal shot, as it did for me with my camera.

At the same time, of course, I was also getting a closer look. In many ways these mouflon are the handsomest, if smallest, of the wild sheep – in this case, particularly, the dark brown contrasting with the white of the rumps extending under the belly. In the older one, not only was there more extensive marking of white in the legs, but the white facial mask extended up over the top of the head and around the ears. The youngest one was darker all over including the legs. In winter the older rams

A mouflon peers cautiously from behind a rocky ledge that commands a good view of the area below — typical behavior for these wary mountain sheep.

Photo by Russ Kinne from Photo Researchers



The Corsican mouflon have sought out inaccessible mountain crags to escape the pressure of poachers. Natural predators have virtually disappeared.

Photo by Walter Kilham

are supposed to have a light colored, if not white, saddle patch over the back. In this case, the ram had the patch but of a light brown. The ewes, with one young, quickly left the ledge for the underbrush and soon all were out of sight as they continued their way up the mountain.

In summer the adult males tend to occupy the forest areas. During the winter, males, females, and young keep to the valley, either in the maquis or the forest of green oaks or arborescent heather. They are not accustomed to pawing through the snow for food as with the dall sheep. As mouflon are among the smallest of the sheep, any great depth of the snow can be a serious handicap to their locomotion. Fortunately for the mouflon, the bulk of their forage – leaves, woody shrubs, and small trees – extends above the average snow so that there is no shortage of food under weather conditions.

Combat—a display of energy

Related to seasonal movements is the social structure of the mouflon family. The period of the rut takes place in the autumn between mid-September and October and December, according to Pierre Pfeffer, who made authoritative studies of the mouflon of Corsica. At the approach of the rut, the large herds break up into small groups and scatter over their whole territory. Promiscuity is the rule. Contrary to popular opinion, any combat of rams is not due to concern with a harem or, generally, of territoriality. In fact, errant rams, in search of females, go from one group to another. Even if there is a ram already with the group, they do not fight. The ram is rarely possessive and the makeup of the group constantly changes, hardly characteristic of a harem. Even when combats do take place, often there are no females around.

Head-on combats are never violent or with a display of bad temper. The rams even take time out in their tourney to graze awhile. One curious note was that the rams turn their heads at the last moment so their foreheads crash and not their horns. The matches, then, are expressive of energy at the time of the rut, rather than rivalry. In fact, when short of an adversary, the rams were observed butting trees and rocks.

At this time a considerable movement of herds and individuals takes place. The solitary ones are rams in search of females. The groups are generally of three to eight animals, and they are of remarkably unstable composition. Any group is basically female, but may include young sheep and even adult males. In mixed herds the oldest female is the leader. She is generally the first to observe danger and the one to give the signal for flight.

Looking across the valley early the next morning, I located three mouflon, the highest up the valley so far. Four mouflon were seen going up the mountain at a fast clip, and no more were seen all day after that. No doubt my criss-crossing of the area for two days had alerted or disturbed them, and they had crossed over to the other side of the mountain and stayed there. Unfortunately, this was my last day and there was not time enough to reconnoiter and find out. I turned down the mountain as the day before, coming out not far from a crystal-clear stream that looked like a beautiful place for trout. Later, I learned that indeed it was, until some poachers had dumped poison in the upper part of the brook. Washing downstream, it had killed all the fish and the stream so far had not recovered.

The next day, I drove back over the mountains through the forests of pine. Great chestnut and oak trees lined the roadside, which lower down passed through astonishingly picturesque villages, all built of granite.

The little expedition was over. I found there are a few mouflon left in Corsica in their original habitat, hopefully on the increase. I had sightings of 45 in all, some of which, of course, were seen more than once. If not quite "endangered" in this major, remaining original habitat, the numbers are small. It is hoped adequate precautions will be taken and protection increased so that these wild sheep of the Mediterranean may survive and prosper for coming generations.

Animal Kingdom Reports

NYZS photo

An adult red-gartered coot feeds the chicks a delicacy dredged up from the bottom of the Bronx Zoo's Flamingo Pond, while the other parent keeps guard. The chicks hatched at the Zoo during June.

RED-GARTERED COOTS BRED AT BRONX ZOO

Two red-gartered coot chicks were hatched by their parents on the Flamingo Pond at the Bronx Zoo during the month of June, the first time this species has been bred in captivity, as far as is known. A black bird with a bright yellow forehead-shield and yellow bill, this species has a red "garter" on its leg, from which it derives its name. Adapted for life on the open water, coots have broadly lobed toes that enable them to swim and dive as easily as ducks.

Watching the red-gartered coots rearing their young at the zoo makes one pause to wonder how the expression "crazy as a coot" originated. While the almost frantic efforts of the breeding pair to feed and defend their chicks may seem somewhat comical at first glance, their actions are really a well-organized handling of family chores.

Hatched on the 18th and 22nd of June, the chicks were at first totally dependent upon their parents, but within a week both of the small jet-black birds were observed feeding from the food containers or diving in the shallows searching for other edibles. Their appetites seemed insatiable and they spent most of the day begging their harassed parents for more food.

By the end of July, when the chicks were more than half-grown, the parents re-nested. It was interesting to note that with the added duties of nest-building, incubating, and defending the nesting site, the parents still found time to carry on occasional bit of food to the youngsters, and to direct a fierce frontal attack on any waterfowl that might approach them. The second nesting produced a single chick on August 28, which the parents are now raising.

The red-gartered coot *(Fulica armillata)* is native to the ponds and marshes of southern South America. Although coots of several species have been bred in collections in Europe and America, the Bronx Zoo's ornithology department can find no other record for a captive breeding of this species.

—Joseph Bell

HOME ON THE RANGE AT THE BRONX ZOO

With the addition of three calves born within the past few months, the American bison herd at the Bronx Zoo now numbers 12 animals. The reddish-colored calves can be seen, along with the dark brown, shaggy-coated adults, on the zoo's Bison Range, a three-acre "prairie" in the Bronx.

Once the vast herds of American bison, conservatively estimated to total 60 million, ranged from western New York State to the Rocky Mountains. Today there are about 30,000 of these animals, more commonly known as buffalo, scattered across the country in zoos, preserves, and private ranges. Small, indeed, as this number may seem in comparison to the earlier millions, it represents a remarkable comeback from the turn of the century when the species seemed on the verge of extinction. (See "Sixty Million Bison," p. 11, this issue.)

As the European settlers moved westward from the Atlantic Ocean across the country, they encountered the buffalo. Towns, mountains, hills, lakes, ponds, and springs in a dozen states and Canadian provences testify to the once local presence of the animal. (It is, however, interesting to note that while Buffalo, New York, was named for the American bison, Buffalo, Wyoming, was named after the eastern city.)

Unfortunately, as the buffalo was encountered, it was slaughtered – at first for its warm robe and the delicacy of its tongue, later to feed the soldiers and railroad crews, but mostly because it was there. Finally, by 1895, it was estimated that fewer than 800 bison remained of the once populous herds.

In 1907, the New York Zoological Society, which operates the Bronx Zoo, shipped a herd of 15 bison to Oklahoma's Wichita Forest Reserve, and in 1913 another herd, this time numbering 14 animals, was shipped to Wind Cave National Park in South Dakota. It has been estimated that all American bison roaming the range today are in part descended from the nucleus herds shipped west from the Bronx Zoo.

The American bison, a close relative of the European bison or wisent, is the largest North American hoofed animal. Its weight varies from 1300 to 2300 pounds, and a male may stand 5 feet 9 inches at the shoulder. Although the American bison is commonly called "buffalo," scientifically speaking this is incorrect. However, use of the word is too firmly established to be changed now and the terms are generally used interchangably.

The buffalo lends itself to many stories, some fact and some fiction. For instance, there are written descriptions of fierce battles between bulls, in which they were reported to rush headlong toward each other at tremendous speed, meeting head on with a loud crash. Exciting as this may be, it is pure imagination.

However, it is true that you should never turn your back on a buffalo. To turn and walk away from a bison that is standing motionless and looking steadily at you is an invitation to the animal to charge. Fortunately, it is claimed that the bull always gives warning of an impending attack by pawing the earth with feet and horns, and uttering a deep, gutteral sound in sharp blasts. Another supposedly infallible sign of an enraged bull is the position of its tail – before charging the American bison holds it high in the air.

FIRST WHALE EVER BRED IN CAPTIVITY BORN AT NEW YORK AQUARIUM

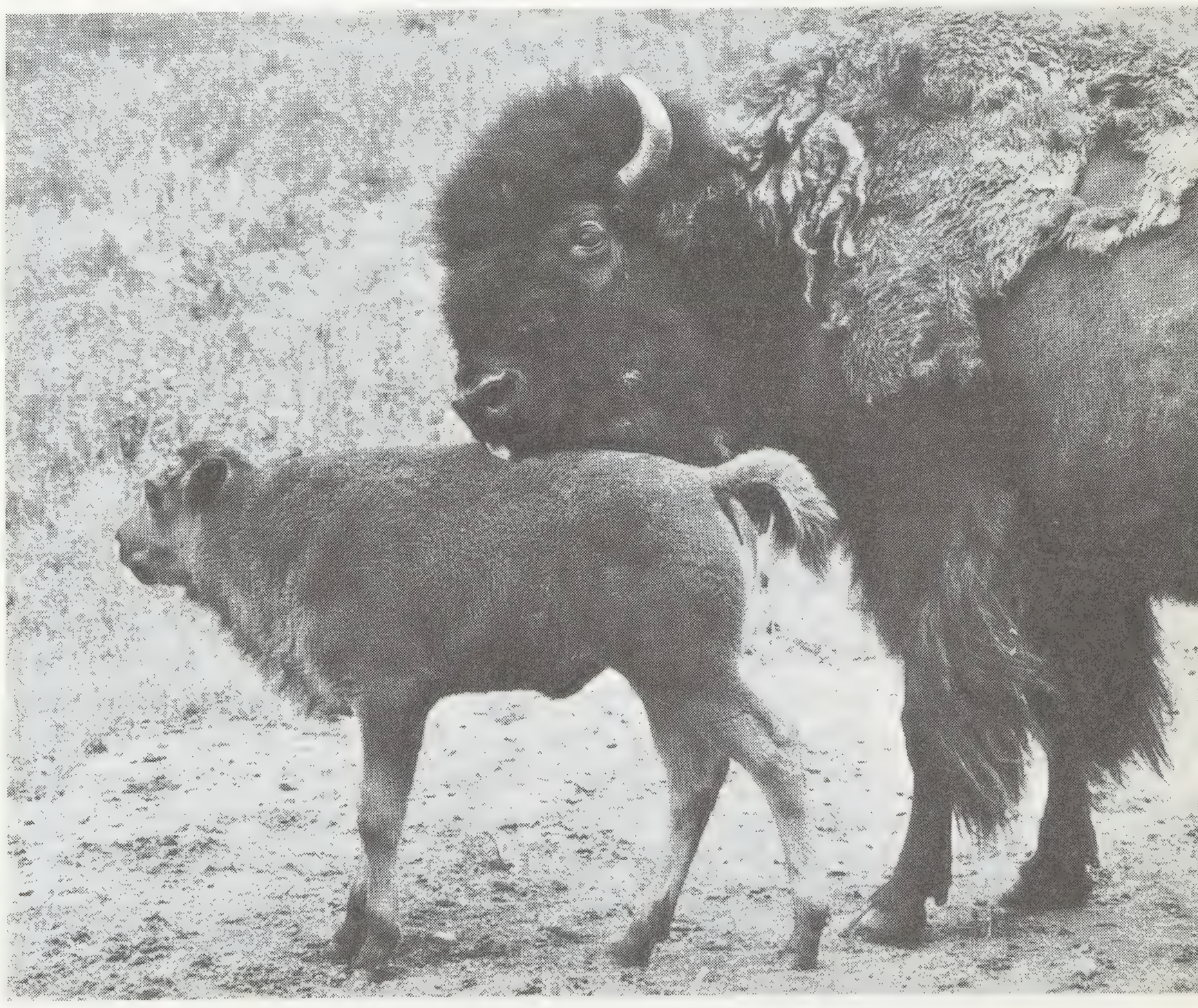
The first whale ever conceived and born in captivity was born at the New York Aquarium at about 3 PM, Saturday, July 22. The birth of the six-foot-long, gray-colored baby whale was witnessed by hundreds of visitors peering through the underwater glass panels of one of the two large whale tanks at the aquarium. The birth of the 50 to 75 pound baby beluga, or white whale, proves that whales can be bred in captivity, a feat never before achieved.

"The animal seemed perfectly formed," said Dr. James A. Oliver, Director of the Aquarium, "and it swam around for about 10 minutes." Sadly, the infant whale suddenly died after its initial swim around its new watery world. An autopsy report gave the cause of death as a massive cerebral hemorrhage.

The parents of the baby whale were Frances and Blanchon, two beluga whales which arrived at the Aquarium in 1967 and 1962, respectively. Since the normal gestation period for this species is about 14 months, it must be concluded that the baby whale was conceived at the Aquarium about one year ago. The beluga whales normally inhabit the Arctic areas of the world's oceans.

Even baby American bison have to stand for a washing from mother, as this youngster demonstrates on the Bison Range at the Bronx Zoo. The calf is one of three young born within the past few months.

NYZS photo



RARE GOLDEN LOBSTER PLACED ON EXHIBIT AT NEW YORK AQUARIUM

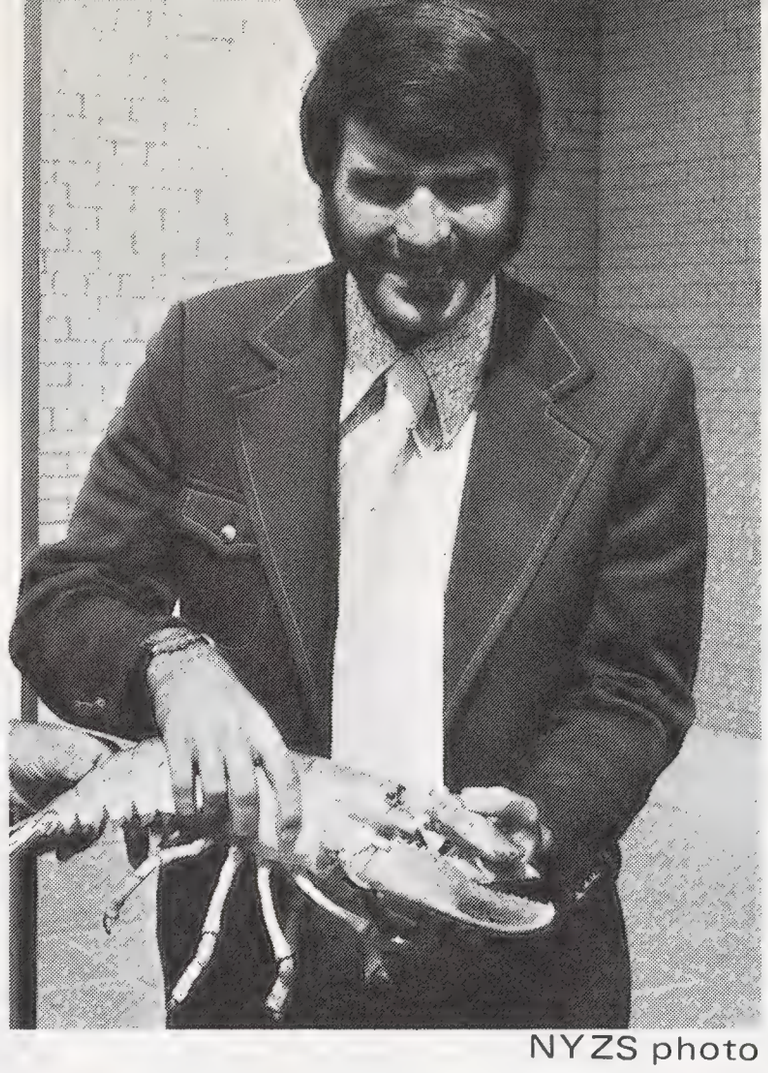
A rare golden lobster – perhaps a one in five-million find – was placed on exhibit at the New York Aquarium in August. Called golden as much for its rarity as for its pigmentation, the yellow-colored female lobster weighs about two pounds. It was caught in the Atlantic Ocean, about 50 to 60 miles east of Hampton, Virginia, at a depth of 150 fathoms by the "Matco I," an 87-foot, deep-water lobster potting vessel operated by a subsidiary of Marine International Corporation of Newark, New Jersey. The lobster was trapped during the week prior to August 8, and Dr. I. William Lane, president of the company, officially presented it to Curator Stephen Spotte at the Aquarium on Wednesday, August 16.

The usual color of the American lobster *(Homarus americanus)* is dull green on the upper part of the shell, with yellow to orange below. However, different color variations do occur – among them red, yellow, and bright blue – due to the lack of certain color pigments in the shell. The underlying color is the bright red of the boiled lobster; boiling destroys the pigments in the shell that produce the normal color of the species.

When the golden lobster first arrived at the Aquarium, it was placed in the lobster exhibit along with others of its species. However, it had to be moved to another exhibit because the other lobsters started to chase the golden lobster around the tank.

The Aquarium also has on exhibit a bright blue lobster, but it is less rare – there are perhaps as many as one in one million.

The American lobster, with its big, pinching claws, is found in the waters off Canada and New England south to Virginia. Like other crustaceans, such as the shrimp and crab, the lobster molts, or sheds its shell, in order to grow. Molting has been found to occur up to 10 times during the first year of life and less frequently thereafter, and at each molt, the lobster will grow some 15 per cent in length and up to 50 per cent in weight.



NYZS photo

Stephen Spotte, Curator of the New York Aquarium, keeps a careful grip on a rare golden lobster — a one-in-five-million find. The Aquarium now has two color variations of the American lobster — blue and gold.

In the natural ocean environment, nearly six years is required for the lobster to reach the one-pound size and sexual maturity. It takes up to 18 months after a successful mating until the eggs finally hatch. The female stores the sperm for nine months until the eggs are laid, at which time the sperm is released to fertilize them. Then the female cements the eggs to the hairs under the tail, where they remain for the last nine months before hatching.

Females lay up to 60,000 eggs at a time, but there is an enormous mortality of the transparent shrimplike little lobsters after they hatch and float to the surface. It takes four moltings in a period of about three weeks before the lobster fry are able to sink to the bottom; most estimates are that fewer than 0.1 per cent of the larvae reach the fourth stage and become bottom crawlers.

News Notes

• The Louisiana Wild Life and Fisheries Commission has decided to open an experimental season for hunting the American alligator, an endangered species, in a restricted section of that state's Cameron Parish. The 13-day season extended from September 5 to 17, and 4,000 alligators were to be taken under "controlled conditions." Only animals over four feet in length could be taken and the hunt was restricted to the hours between sunrise and sunset. It has been estimated by the commission that there are 50,000 alligators in that particular area, although alligator populations remain low in many parishes of Louisiana and several other states where the species naturally occurs.

• Interior Secretary Rogers Morton, whose department sets hunting regulations for migratory game birds in the United States, announced in June a pilot program on selected federal hunting areas this fall using iron shot as a substitute for lead shot in hunting. Spent lead shot, picked up accidentally by feeding waterfowl, poisons the birds and has taken a heavy toll of ducks, geese, and swans over the years. Biologists estimate three to four per cent of the waterfowl population of North America dies each year from lead poisoning, a loss of millions of birds.

If this fall's program is successful, the pilot effort will be expanded the following season and iron shot may be mandatory for all waterfowl hunting in 1974.

• Waterfowl habitat conditions almost as favorable as last year are being reported to the Department of the Interior's Fish and Wildlife Service from an extensive air and ground survey of nesting areas in the United States and Canada. Duck populations appear about the same as in 1971, which was considered a relatively good production year. Temperatures have been moderate and the nesting season is underway earlier than usual.

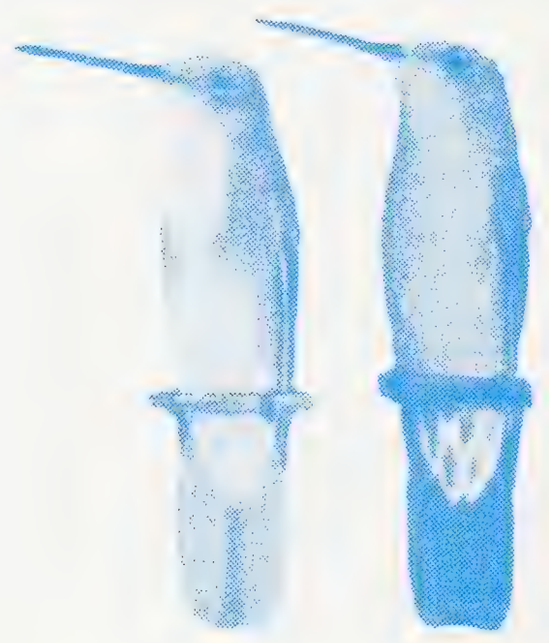
FIELD GUIDES TO CENTRAL AMERICAN BIRDS

If you are planning a trip to Mexico or any other Central American country, there are a number of fairly recent field guides available to help you identify the birds you might see in your travels, and provide some information on their habits and distribution. One of the finest of these is BIRDS OF GUATAMALA, by Hugh C. Land (published for the International Committee for Bird Preservation by the Livingston Publishing Company, Wynnewood, Pennsylvania 19096, $10.00). The introduction includes discussions of the geography, climate, and ornithological history of Guatamala. Species accounts form the major portion of this work; each of the avian families represented in the book is prefaced by a brief account of special characteristics, world-wide distribution, and the number of species found in Guatamala. In all, more than 660 species are catalogued by common English, Spanish, and scientific names.

Maps for each of the species show range and population density, and brief written descriptions are given where needed. Data on status, habitat, habits, song, and subspecies (when more than one race occurs in Guatamala) round out the text. Published in 1970, this field guide has 44 color plates representing about 300 forms. Half of the plates were produced by the author himself, and the remainder by H. Wayne Trimm, staff artist for the New York State Department of Conservation. Mr. Trimm's illustrations (many reproduced from an earlier work) are excellent; the author's are not of the same quality but are still quite acceptable for identification purposes.

THE BIRDS OF TIKAL by Frank B. Smithe (Natural History Press, Garden City, New York, $7.50), published four years earlier, also deals with Guatamalan birds. However, it restricts itself mainly to the species that might be encountered by tourists and archeologists visiting the famous and extensive Mayan ruins at Tikal in the northern Guatamala Department of El Peten. This guide, too, includes some details of geography, climate, vegetation, etc., in its introduction, along with a brief history of the Mayans, photographs of the ruins, and a painting of the Great Plaza at Tikal as it might have appeared when the Mayan civilization flourished.

The area involved is so small that the species accounts do not include maps, but a written general range is given for each species. A section at the end of each species account gives references to other sources for data on song, nests, eggs, life histories, and illustrations. Thirty plates in full color depicting over 100 species were executed by H. Wayne Trimm (some 22 of these are also included in *Birds of Guatamala).* The book also features two maps, a chart showing daily rainfalls and temperatures for a three-year period, and a section (with drawings) identifying the pensile (hanging) nests of about a dozen flycatchers.



FIELD GUIDE TO THE BIRDS OF MEXICO by Ernest P. Edwards (published by Ernest P. Edwards, Sweet Briar, Virginia 24595, $8.50) appeared in March of this year, filling an ornithological gap for both the amateur and the professional naturalist. While it is true that Emmet Blake's classical and excellent *Birds of Mexico* has been in existence since 1952, a guide that featured identification plates in full color was sorely needed. Nearly 1,000 species of birds representing more than 80 avian families occur within the boundaries of Mexico; 700 are resident species. The new Edwards' guide illustrates about 500, providing details of range, habits, habitat, and behavior.

An unusual and thoughtful innovation in the present work is a brief description for each species in Spanish, a feature that provides a much broader range of utility than most publications of this type. There are no range maps in this guide, but written descriptions supply the general area occupied by each species. A system designed to match each species with a region or type of habitat by a series of abbreviations is not successful or practical, but grouping all of the color plates in a single section of the

book is a happy solution for rapid search, provided one is familiar with standard phylogenetics. The illustrations are the works of four artists, including the author; the plates by Murrell Butler and John P. O'Neill are superior to the others.

Also making its first appearance in 1972 was A FIELD GUIDE TO THE BIRDS OF MEXICO AND CENTRAL AMERICA by L. Irby Davis (University of Texas Press, Austin, $10.00). This rather confusing volume attempts to separate many of the species by song. The text and descriptions make an unsuccessful field guide, but the 48 color plates by F. P. Bennet, Jr., are better than average.

Technical criticisms of nomenclature have been omitted from this review as not being pertinent to the general usefulness of the field guides discussed.

– Joseph Bell

THE STREAM

By Robert Murphy. Farrar, Straus and Giroux, New York, 1971. $6.95.

For those who have known the Lackawaxen, the Shohola, the Brodhead, or any of the other Pocono Mountain waterways that course their way to the Delaware River, *The Stream* will have a special, if not personal, message. For those who have enjoyed *The Peregrine Falcon, The Mountain Lion,* or another of Robert Murphy's earlier works, *The Stream* most certainly will not be a disappointment.

The author has chosen a 2,000-acre tract of unspoiled habitat in mountainous northeastern Pennsylvania as the setting of his fictional account. His story involves a 10-member club of men which has owned the tract for many years. While using the land for fishing, hunting, and camping, their primary interest has been to preserve the pristine beauty of the land, and the stream which flows through it, and to maintain it free from the destructive influences of man.

Unfortunately, human "progress" – the metastasizing cancer which has so terribly disfigured the Poconos in recent years – exerts its pressures on the sanctuary. The tract is aerially bombarded with an overdose of DDT. An oil company uses the right of eminent domain to acquire property to accommodate its snaking pipeline. And the omnipresent road builders, "land developers," and dam builders make encroachments that have profound ecological effects on the property.

With apparent firsthand knowledge of the biology of the region, the author uses his gifted descriptive powers to full advantage as he discusses the natural history within the tract and the ecological disruptions that take place therein. He also skillfully develops Jerry Ohlmstead, the story's principal character, who lives nearest to the tract and has a profoundly personal relationship to the land.

Many, like Murphy's Jerry Ohlmstead, become exhausted and finally overcome by the insidious rape of their environment, and quietly, a part of them dies. Slowly, then, arises a different man – a man totally committed to the preservation of what remains. *The Stream* perhaps is part of the author's commitment.

– John Behler

HOW TO TALK TO BIRDS

By Richard C. Davids. 242 pp. Alfred A. Knopf, Inc., New York, 1972. $6.95.

If you feed birds, hunt animals with a camera, wonder about mosses and liverworts, and get excited about swamping, here's a book to keep you going for the next year.

Richard Davis offers a wealth of nature information in a style that portrays a deep abiding interest in the subject matter. Practical suggestions range from indoor gardening under lights and grafting to guiding children on nature walks and learning toad calls.

For those city dwellers with more interest than space, there are many hints of things to do in your city apartments. To suburban and rural people the choices are even greater.

As he describes the "purple poetry" in seed and garden catalogs, my own interest grows more intense. I know full well the heights of splendor that are described (but rarely fulfilled) by the seedsman's pen. Davis' resounding successes (gloxinias) and equally distressing failures (loofa gourds) make for great moral support. Having run through spaghetti plants, achimenes, and pitcher plants myself, it is easy to empathize with the small successes and failures he finds related to the "soon to be yours" wonders of the seed catalog. The author provides quotes from historic garden fans, including George Washington's seed orders and Benjamin Franklin's excursion with rhubarb, and a few other historical tidbits from seed catalogs of the eighteenth century.

Rachael Carson wrote of a "sense of wonder" – some intangible spark of interest in all things that can ignite one's imagination and give fire to life. Davis' book is kindling to that fire.

– James W. Waddick

"...when the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can be again."
– William Beebe
First curator of birds, Bronx Zoo

Vanishing Species

TOADS

Toads are familiar creatures – their warty textured skins, squat bodies, short stocky legs, and hopping gait are a collection of characteristics which are not seen among the other amphibians. Typically, the members of the bufonid family have eyes with horizontal pupils and large poison-producing parotid glands strategically located behind them.

These same distinctive features are seen among toads occurring around the globe. The genus *Bufo* occurs naturally in all continents except Australia and Antarctica and is found from sea-level desert localities to 15,000-foot elevations in the Himalayas.

Although the majority of toads are between three and four inches in length, they range in size from the one-inch oak toad *(Bufo quercicus)* from the pinewoods of southeastern United States, and the similar-sized rose toad *(B. rosei)* from the mountain slopes above Capetown, South Africa, to the giant 10-inch-long rococo toad *(B. paracnemis)* from South America. The rococo toad and the seven-inch Colorado River toad *(B. alvarius),* our largest native species, not only consume phenomenal quantities of insects daily, but they may frequently include sparrow-sized birds, assorted amphibians and reptiles, and small rodents in their diet.

For those who have witnessed the countless thousands of strings of black eggs left at the breeding ponds by our common garden species of toads, it is indeed difficult to imagine that there are some species of toads whose survival is threatened. However, several species of toads occurring in the United States are endangered and the reasons for their peril are abundantly clear. Unlike the American toad *(B. americanus),* Woodhouse's toad *(B. woodhousei),* and the western toad *(B. boreas)* which range over large portions of the country and occupy a variety of habitats, the vanishing species are confined to a small area and have very narrow habitat requirements. One of these, the black toad *(B. exsul),* has one of the most restrictive ranges known. This lacquerblack colored two-inch toad is found solely in a twelve acre area of springs, their channels, and marshes in the southwestern part of Deep Springs Valley, Inyo County, California. It has been postulated that the ancestral stock of the black toad reached the valley during the Pleistocene and became isolated in its springs as the surrounding region became increasingly arid with passing years.

Presently, both the I.U.C.N. (International Union for the Conservation of Nature and Natural Resources) and the U.S. Department of the Interior include the black, or exile toad, as it is also known, in their "redbooks" of rare and endangered species.

The Houston toad *(B. houstonensis),* like the black toad, is a species with severely limited habitat requirements. As its name implies, *B. houstonensis* resides in south-central Texas where it is known to occur in nine relictual populations. This species too is a "redbook" member and its "endangered" status therein designates that it is on the verge of extinction. In appearance, the two-and-one-half-inch Houston toad looks much like a small American toad. Some believe that the toad was left behind in isolated stands of loblolly pine as the American toad retreated northward following the Pleistocene.

The reasons for the Houston toads' decline are several. Destruction of many of the disjunct pine stands through extensive lumbering and landclearing has eliminated some of the populations of the toad outright. Climatological changes and the growth of the City of Houston has spelled the demise of additional populations. It has now been reported that natural hybridization between the Houston toad and two other species is taking place and may well result in *B. houstonensis* being genetically swamped.

Two additional toads, the Amargosa toad *(B. boreas nelsoni)* which is found only in the Amargosa River Valley in the vicinity of Springdale and Beatty, Nevada, and the Sonoran green toad *(B. retiformis)* which ranges from south-central Arizona to west-central Sonora are rarely seen and are currently carried on the I.U.C.N.'s "undeterminate" status list. Although there is insufficient data to accurately assess the status of either of these forms, it appears that the populations of the Sonoran green toad suffer most from over-collecting, while those of the arid dwelling Amargosa toad have been pressured by human demands for water.

Although we have been able to collect impressive series of our rare amphibians, their pickled bodies have not told us much about what links them to their particular environment. Nor, in many cases, have we learned enough to save them. However, it is known that many species of toads can easily be induced to breed in captivity. Certainly the Houston toad, which frequently is unable to breed because of extended periods of drought, is a candidate for captive rearing studies. If such action is taken, at least the line in the "redbook" would not end with "protective measures taken: NONE." *– John L. Behler*

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Animal Kingdom

MAGAZINE OF THE NEW YORK ZOOLOGICAL SOCIETY

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by Stephen Spotte

The nation's first underwater nature preserve, off Key Largo, Florida, is a diver's paradise. Its living coral reefs harbor a wealth of marine life that can be viewed from glass-bottomed boats or explored with scuba gear and camera. The creatures within its 75,000 submarine acres are fully protected by law.

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Animal Crowding
by David Van Vleck

There's more to mammal survival than food and shelter – the stress of crowding can put a damper on reproduction and cut down populations. Lions, deer, monkeys, and lemmings are some of the many species that need elbow room to thrive and multiply.

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A Giraffe is Born
Photography by Angelo Calcaterra

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The Weaver Finches of Hispaniola
by William D. Fitzwater

Brought to the New World over two centuries ago, these native African birds have thrived on the rice crops of Hispaniola, where they are now regarded as a troublesome pest. More study of their life habits is needed before population controls can be evolved.

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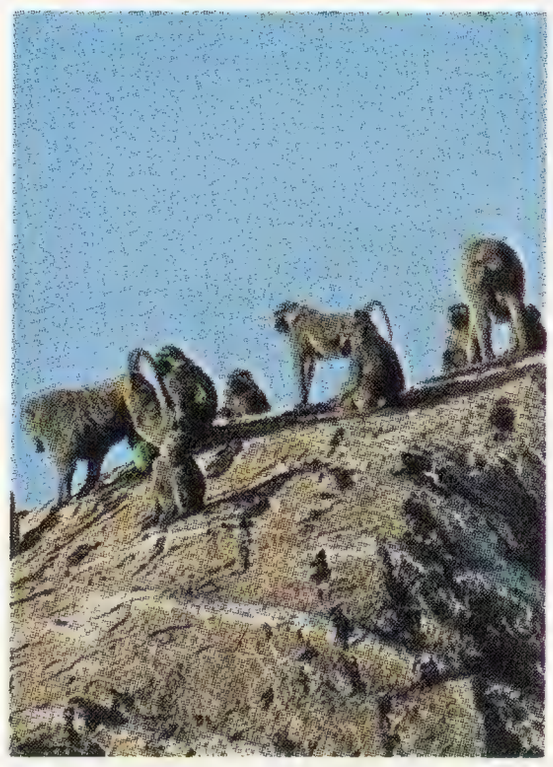
To Save Salamander
by Joseph W. Shaw

The lungless Jerez Mountain salamander is a relic from another age, isolated within a pocket of climate in the mountains of New Mexico. Endangered by the lumberman's saw, this small salamander is being studied in its sole remaining habitat.



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Vanishing Species *Inside Back Cover*

About the cover

Spotlighted by the morning sunlight in a forest clearing, these red deer face more than their daily search for food – they also need space for survival. Crowding can disrupt their mating and maternity, reduce their fertility, and lead to malnutrition in the young. The result: A sharp drop in population. These are but one of many species of mammals that are sensitive to the stress of crowding. *Photo by H. Reinhard from Bruce Coleman*

Back cover: A Siberian tiger, perhaps the most majestic of the big cats, hovers protectively over its cub, born at the Bronx Zoo. Close to extinction in the wild, it has bred successfully in captivity. (See Vanishing Species, inside back cover.) *NYZS photo by Bill Meng*

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Pennekamp's Wet World

by Stephen Spotte

Florida's John Pennekamp Coral Reef State Park is the first exclusively underwater preserve created in America. Its 75,000 acres are located off Key Largo only a one-hour drive on the Overseas Highway from downtown Miami

Colorful reef fishes, corals, shells, lobsters, and sunken wrecks — all are on view to visitors at the John Pennekamp Coral Reef State Park.

Key Largo in the Florida Keys is the poor man's Tahiti. For the price of a bus ticket from, say, Buffalo or Chicago, any would-be Fletcher Christian can retire to a life of solitude beneath the palms. Or so it would seem in theory.

In actual practice things are rarely so simple. Within sight of the Overseas Highway, solitude is that time of day when the bulldozer operators are on their lunch break, and the palm trees have a fat, complacent look that can only be imparted by garden clubs. From such a vantage point it would be natural to think of Key Largo as a suburb of Miami Beach.

This image dissipates when you turn onto the road marked *Entrance to John Pennekamp Coral Reef State Park.* About the same time, you notice the breeze has died somewhere in the thick underbrush and the searing heat descends like a blanket. The roar and tangle of the highway are replaced by humming mosquitoes, which know from experience that the road is too narrow to allow escape by automobile. Abruptly and without warning, you come to the edge of the sea, and at this point the park begins. Pennekamp Park, you see, is located under the Atlantic Ocean. It was the first exclusively underwater preserve created in America.

The protection would never have come about were it not for the defilers. After World War II, curio shops sprang up like mushrooms along Florida's highways to serve the burgeoning influx of tourists. Corals, bleached and dry, were a favorite item, and so were sea fans, dried sponges, and the gaudy queen conch shells. Collectors of these items attacked the reefs with crowbars and dynamite, often decimating entire areas in a few hours.

Stephen Spotte, an avid scuba diver, formerly resided in Key Largo, where he was a frequent visitor to the John Pennekamp Coral Reef State Park. He is presently Curator of the New York Aquarium.

The "Reef Queen" prepares to leave Key Largo with a boat-load of divers for Pennekamp State Park and underwater tours of the reefs.

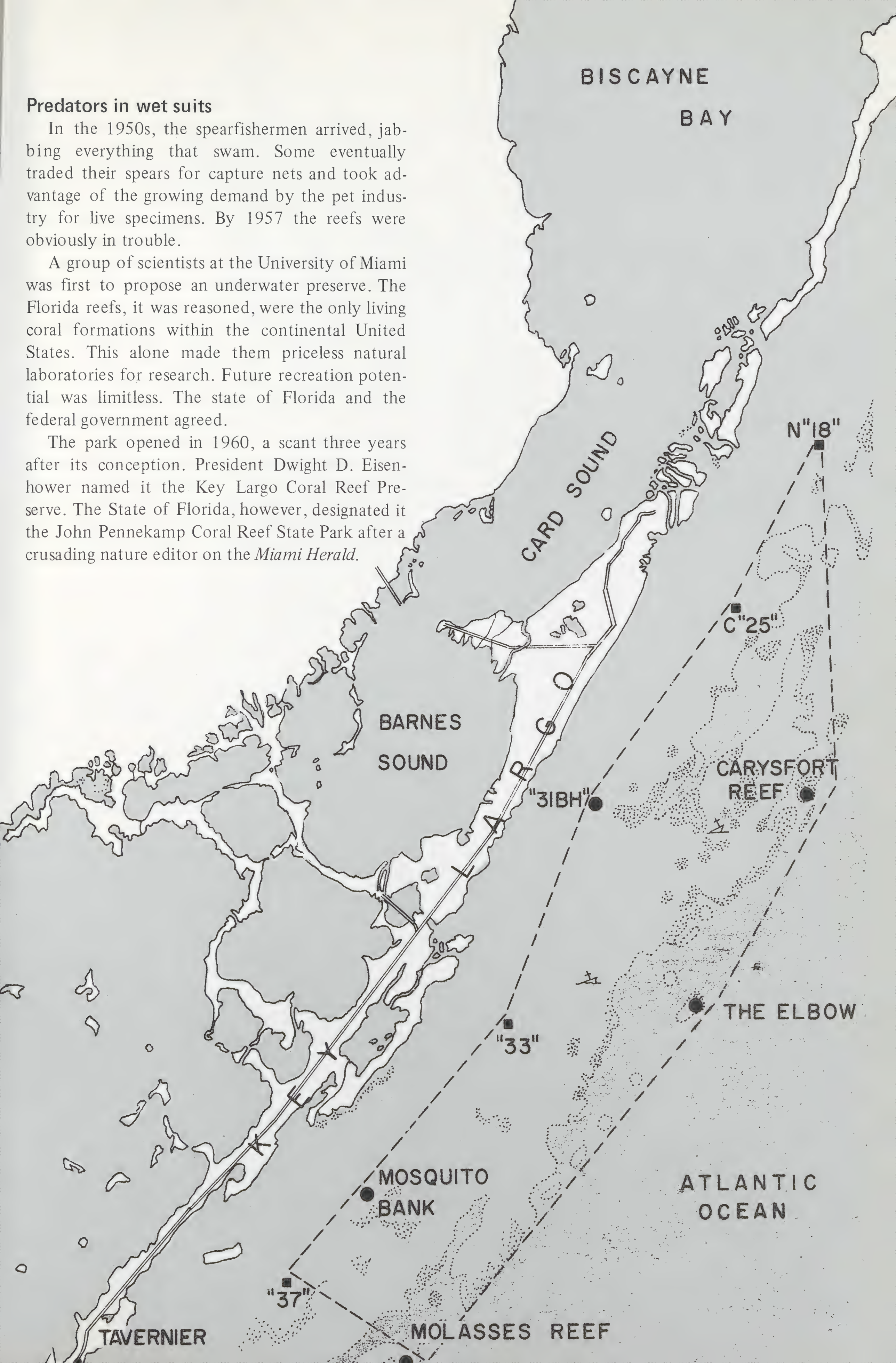
Photos and map from Carl Gage, Key Largo, Fla.

Predators in wet suits

In the 1950s, the spearfishermen arrived, jabbing everything that swam. Some eventually traded their spears for capture nets and took advantage of the growing demand by the pet industry for live specimens. By 1957 the reefs were obviously in trouble.

A group of scientists at the University of Miami was first to propose an underwater preserve. The Florida reefs, it was reasoned, were the only living coral formations within the continental United States. This alone made them priceless natural laboratories for research. Future recreation potential was limitless. The state of Florida and the federal government agreed.

The park opened in 1960, a scant three years after its conception. President Dwight D. Eisenhower named it the Key Largo Coral Reef Preserve. The State of Florida, however, designated it the John Pennekamp Coral Reef State Park after a crusading nature editor on the *Miami Herald*.



The sea squirts or tunicates are inch-long filter-feeders which attach themselves to rocks.

Living flower coral, one of the numerous invertebrate creatures that populate the surface of the reef.

The purple encrusting sponge assumes the shape of the object on which it grows.

A close-up of living brain coral shows the green algae that grows in the tissues of the coral polyp.

The flexible sea whips look almost plantlike as they bend and sway with the currents. These "soft corals" do not secrete a stony shell, are not reef builders.

Pennekamp State Park contains the only living coral reef within the continental United States. It abounds with a variety of coral reef fishes, such as the school of grunts shown above at the entrance to one of the reef's many unexplored caves. The crystal-clear water makes the park a photographer's underwater paradise.

With creation of the park came automatic protection of every living creature inside the 75,130 acres. Collecting live specimens, corals, shells, and other life-forms is strictly prohibited. So is spearfishing. Only rod and reel fishing is permitted, and the taking of lobsters in season.

There are two ways to inspect the living reefs. The drier way is to look down at it through the viewing windows of the glass-bottomed boat operated by the parks department. Trips leave the dock at the concession building daily, and for a nominal fee the visitor can watch the undersea world in maximum comfort.

But the second way is best. Put on scuba gear and go down and see it in person. The park concession rents boats and diving equipment for those who want to explore the reefs on their own. Several private concerns adjacent to the park offer daily supervised trips. The largest and most efficient is the Carl Gage Diving Center. Mr. Gage's service has to be one of the few real bargains left in Florida. A full day of diving – one snorkel dive and two scuba dives on the deeper reefs – runs just $10. This includes transportation to and from the reefs on one of his two specially equipped dive boats, the 50-passenger *Reef Queen* or the 20-passenger *Henrietta,* plus use of all diving equipment from tanks and regulators right down to flippers, mask, snorkel, and safety vest. All dives are conducted under supervision of tour leaders who know the reefs intimately and who must first pass Mr. Gage's rigid qualifying course in diving safety.

Sea Gardens on the reef

Actually there are several reefs within Pennekamp's boundaries. Most accessible is an area known as Sea Gardens, where no spot is deeper than 15 feet and many are exposed at low tide, making handy places to stand for the weary diver. As its name implies, Sea Gardens is a collage of living invertebrates. Soft corals predominate: sea fans, sea whips, and their relatives thrive in this shallow, protected pocket of the reef. Sea fans seem to consistently grow with their flat sides pointing in the same direction, thus exposing a greater surface to tidal changes and the incoming planktonic organisms upon which the polyps feed. The arrangement gives Sea Garden's sea fans the eerie look of having been planted.

The most famous sight in the park is the "Christ of the Deep," a nine-foot bronze statue standing in a coral grotto in 20 feet of water. The statue was created by sculptor Guido Galletti of Italy. It weighs two tons and is supported by a 20-ton concrete base. The statue is an exact replica of the "Christ of the Abysses," which was placed in 50 feet of water in the Mediterranean Sea near Genoa in 1954.

I often used the statue as a landmark for locating a large colony of yellowheaded jawfish that lived nearby. Jawfish are unique in the fish world. I for one could never resist a fish that looked at me with the sad, luminous eyes of an actor mouthing silent lines to a submarine audience.

A jawfish spends most of its day at the entrance to its burrow, diving into it prairie dog fashion when danger threatens. After a few days of constant observation, my presence stopped irritating them and they went about their normal activities as if I didn't exist. This is quite a tribute, considering that I am nearly six feet long to each of their two inches, and that I tend to bubble loudly, even during the more delicate moments of jawfish courtship.

Watching grunts and goatfish

Molasses Reef is the place to go fish-watching. Molasses is really two parallel reefs with a deep canyon separating them. Average depth is 30 feet. If you anchor to the landward end of the canyon and start swimming from there, an enormous school of white and French grunts, along with some goatfish, will mill along in front. By the time you reach the entrance of the canyon to seaward, the school will have swollen to thousands of fishes. Suddenly they disperse and rush back along the canyon walls to their original places.

The reefs are remarkably free of trash. Even Molasses with its numerous diving parties is devoid of beer cans. Why should this undersea canyon be any different from the edge of the highway only a few miles away? Are the reef people a cleaner breed, or is there another answer? Both, I think. The litterbugs still come, of course, but even for them I am now convinced that littering is a conscious act, and for this reason there is hope. Quite simply, it is inconvenient to litter from a boat, particularly when the sea and its feel are strange. Maybe after the hassle with the diving equipment, after the seasick pills, after the sandwich better left uneaten, and the regulator that wheezes sickly, after all this, who can remember to drop his refuse over the side?

French Reef is slightly deeper – 40 feet – with less animal life. But French Reef has something

A diver explores the half-buried hull of the American tanker M/V Benwood — one of two sunken wrecks in the park that delight treasure-seeking divers.

special of its own to offer. It is a labyrinth of caves, many large enough to accommodate a scuba diver. Sand Floor Cave starts as a yawning void beneath a ledge of coral on the ocean bottom. The tunnel gradually narrows until 30 feet inside, where it takes a sudden upward turn and discharges you in daylight at the top of the reef. As its name indicates, the floor of this cave is covered with snow-white sand the color and texture of granular sugar.

Growing on the rocks nearby in low, flat spheres of green are patches of the algae, *Halimeda. Halimeda* assimilates sea water and excretes calcium carbonate in small crystals. The bottom of Sand Floor Cave is composed entirely of these crystals.

Ships from the past

Not far from French Reef is the wreck of the *M/V Benwood,* an American tanker sunk after a mysterious collision in 1942. The stern of the *Benwood* lies in 25 feet of water, the bow in 45 feet. On calm days the entire outline of the doomed vessel can be seen from the surface.

Diving to the wreck is a ghostly experience. Scattered about the deck are great rusting winches with yard after yard of tussled cable. Giant groupers have taken up residence in the hold and sea fans grow along the railings. Schools of eagle rays sometimes sweep across the shattered bow like sea birds in a blue sky, but no officer stands on the bridge to watch them. The sea will eventually reduce the *Benwood* to its basic elements, and what it cannot readily dissolve, it is temporarily hiding under relentless layers of coral and sponge.

In the northeastern corner of the park near Carysfort Light lie the remains of the *H. M. S. Winchester.* The *Winchester* was a British ship of the line, carrying 60 guns and a crew of 350 men. She had left Jamaica and was sailing for England in September 1695, when she was sunk in a storm and went down on the reef. Only eight men survived. Parts of the wreck can still be found, resting patiently in the sand. *Halimeda* and the drift of centuries are doing their best to give her a proper burial.

This is Pennekamp's wet world. The question I sometimes ask myself, the obvious one I suppose, is why do I come here? What exactly is the appeal?

The call of the deep

The dilemma is most often pondered as I struggle into a wetsuit on the deck of a pitching boat, or while wrestling with the heavy scuba tank and the regulator that keeps me alive. The flippers. Aren't they more than a little fish-like? What is it that sends my blood pounding when I tumble awkwardly out of the atmosphere and smoothly under the waves? Perhaps it is deeper into myself than I care to look. Perhaps it isn't the strangeness of the reef at all, but the terrible familiarity.

The diver drifts in a soporific void. Sweat and the glare of the sun are gone. Weight is no longer obtrusive, and mass, the intrinsic reminder of

Conch shells and other live specimens can be examined and admired, but they must be left behind when the diver surfaces. Every living creature within the park is protected by law.

physical limitation, dwindles to insignificance. Visual images are magnified; objects look closer. Hearing becomes a more sensitive receiver of signals because sound travels quickly along the densely-packed molecules of water. Where was it once, long ago, that I floated out of a dream such as this?

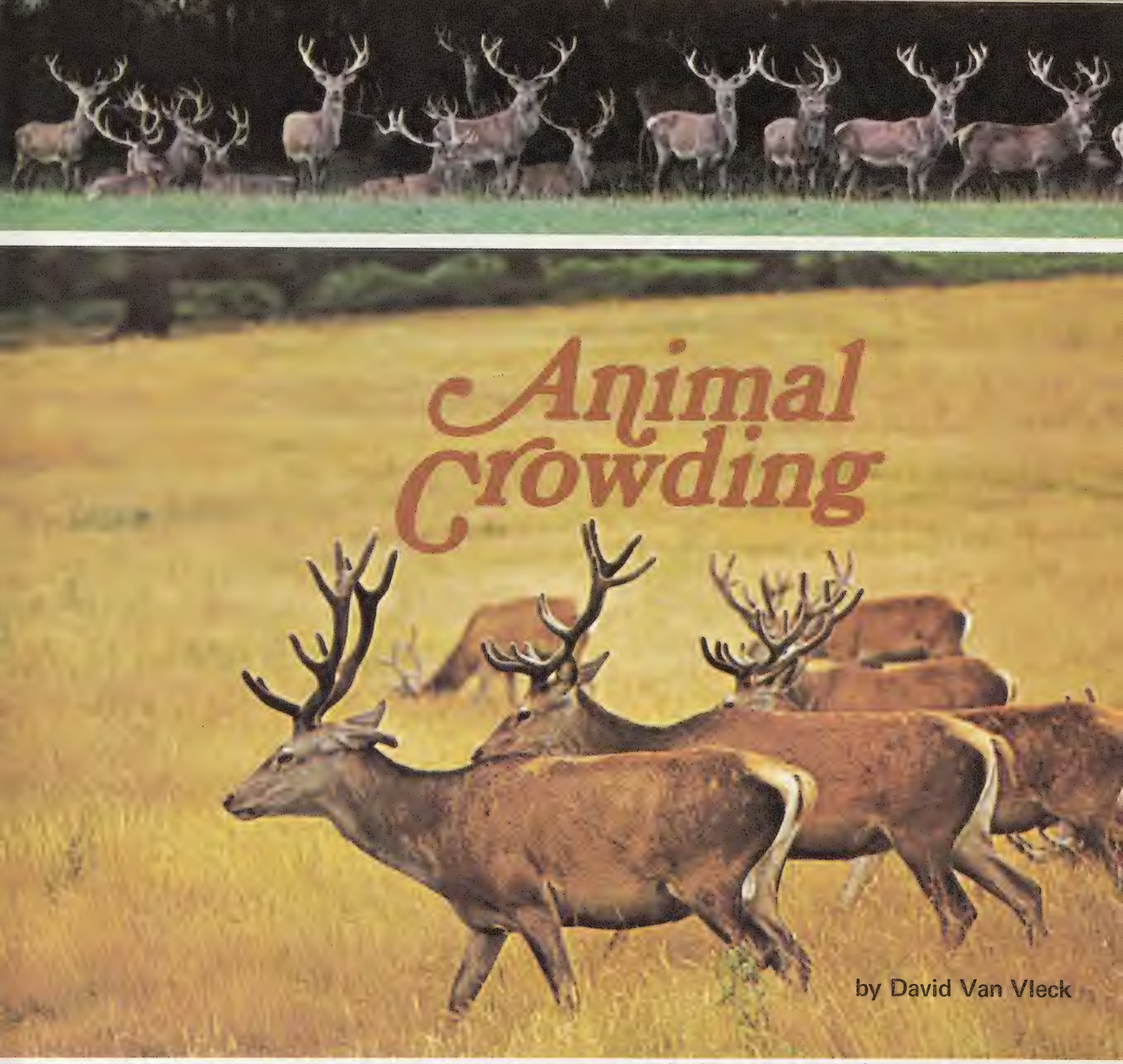
Try and make the reef an enchanted forest and it will be easier. Forests, after all, belong to the land. As you enter this one, the sunlight is stopped by a blue curtain and the condensed vapor of an alien world envelops you in a wet shroud. Elkhorn corals rise in flat spirals towards the surface, each living polyp germinating on the skeletons of dead brethren. On the upper plains, staghorn corals grow in impossible tangles like squat, thorny bushes. Brightly colored fishes flit like birds through the higher branches; shrimps cling locust-like to the trunks; and through the roots and across the ocean floor, spiny lobsters march to an unheard drumbeat, as stately and precise as Caesar's legions.

The bubbles from your regulator are a noisy intrusion. Other inhabitants of the reef move soundlessly in this liquid world. Their communications are subtle vibrations on lateral lines and messages broadcast with the gentle crackle of short-wave radios, except the senders and receivers are scuttling crustaceans. Sight is limited and swirl of scent borne on the current is as telltale as shape and color. Predation is therefore swift and efficient, even though myopia is a way of life.

Dusk on a flat sea. The beacon marking the edge of the reef at Carysfort blinks monotonously like a mechanical cyclops. No lights streak outward from the land because only mangroves line the bank, and they are black now. If the answer is to be found, this is the time and the place. Alone in the small boat, it is difficult to position myself to slip into the harness of the backpack, but finally everything is in place. The last light hurries westward over the silver face of the sea.

I've entered crystal chambers of darkness, descending slowly. Night rushes up and envelopes my ankles. Suddenly the jagged reef overhead, towering like a cathedral. Through its windows my own eyes stare back at me, the lidless eyes of sleeping fish.

Strange music rises from the rocks, faintly at first, as unseen hundreds of creatures telegraph their presence: rich chords from liquid harps, sad lingerings on a distant flute, a languid clarinet. I pause and hold my breath and the symphony rushes forward across the vast and unlit stage. Your melodies are somehow familiar, dark sea, even though they are older than memory.



Animal Crowding

by David Van Vleck

Photo (top) by Walter Murray from Bruce Coleman, (bottom) by Mathias Oppersdorff from Photo Researchers

Red deer stags, such as these at Richmond Park, London, will fight when crowded, killing young and strange male adults.

Living space seems to be a key to the mammal population puzzle. Under the stress of crowding, both mating and motherhood are disrupted.

Man does not live by bread alone, and neither do wild animals. Elephants lions, and many other species seem to maintain stable populations in the wild – though food supplies may vary widely over the years. Starvation, predators, and disease do take their toll from animal populations, but other, more subtle forces are also at work. When animals are pressed for space, the stress of crowding seems to place a lid on reproduction. Just how this occurs is not fully known, but the process is vital to conservation and wildlife management.

As a graduate student at Cornell University, I livetrapped and marked hundreds of field mice during three successive summers. By recapturing individuals I could tell which were pregnant, how fast they grew, and the number of embryos in a pregnant mother. One June the population was

David Van Vleck, formerly Associate Professor of Biology at Middlebury College, Vt., has studied mammal populations in the field. He is presently writing a book on organic gardening and human population.

very high, and at dusk I could listen to the squeals as the mice chased each other in encounters of love, anger or play. It was a healthy population. However, by August the population had faded away, it seemed. No more sounds were heard, and the number of mice in the traps decreased sharply. Obviously some important factor that was necessary to support a large population had disappeared.

The growth and decline of populations is not unique to mice — it is also characteristic of large mammals, such as deer, moose, reindeer, wolves and wildcats. For instance, in 1910, 25 reindeer were placed on one of the Pribilof Islands in Alaska. They lived well because of the abundant supply of lichen, their staple food. By 1938 there were 2,000 animals; 12 years later there were only eight. A similar situation occurred on another island where a population of 29 reindeer in 1944 increased to 6,000 in 1963 before decreasing to 42 in 1964. In both instances the deer starved to death after eradicating their food supply.

The causes of population declines of small mammals are not always so obvious. Predation, disease and starvation traditionally have been blamed for such decreases, but most population ecologists now think that predation and disease rarely explain population declines, and starvation is a critical factor only during winter months.

Very little is known about the effects of crowding on most species of mammals. Birds and large mammals are more easily studied in nature than are small mammals. Scientists cannot squeeze into a mouse runway to observe their behavior and problems. Yet their great ability to reproduce, their short gestation period and short generation intervals make these rodents favorite subjects for ecologists and behaviorists interested in the consequences of crowding.

Stress on motherhood

To study some effects of crowding on rats, I set up 15 cages, some as freely growing populations and some as controls. The controls were thinned occasionally so overpopulation would not occur. As the experimental populations increased in density, the behavior of the mothers changed first. The "good" mothers — those that had built nests, nursed, and protected their young — became careless under the pressure of crowding. They began to maul their young by biting limbs and tail, and finally they killed entire litters. Instead of building nests with the nesting material we provided, they bore their young in a corner and then deserted them after a time. Sometimes when the young were nursing, the mother would move away in order to eat, drink or to avoid the interference of other rats. If a nursing baby fell off, the mother would leave it, instead of carrying it back to the nest in the normal fashion. The males, finding babies on the floor of the cage, killed them. This behavior never occurred in the low density cages that were located in an adjoining area.

Other recent studies suggest that crowding puts mammals under stress. This stress is transmitted to animals that are not directly in touch with the stressed animals. In one experiment, stress occurred in mice that had contact with a dense population, regardless of the sensory type of contact, and litter survival was affected in all mice.

Dropouts and probers

John Calhoun, a research psychologist at the National Institute of Mental Health, has found similar results of high population density with mice and rats. Initially, he investigated the social symptoms of rats living under dense and non-dense conditions. In the freely growing colony, some parts remained low in population, while other parts grew very dense. The low populations remained so because dominant males maintained harems of females while keeping out all other males. As a result, some sections of the enclosure became very crowded and certain social disorders resulted. These disorders were classified by sex.

Males were classified by Dr. Calhoun into four groups: normal, pansexuals, social dropouts and probers. The normal males were dominant and aggressive, but even they went "berserk" sometimes and attacked males, females and even juveniles, behavior that is quite abnormal for these rats. The *pansexuals* made advances toward juveniles and females that were not in estrus, which is the usual period of acceptance of males. *Social dropouts* were those that did not compete for social status; they were completely passive, making no advances on estrus females, and were completely disoriented socially. The *probers* were those rats that did not compete for social status and had none, but unlike the dropouts, the probers were hyperactive. These were the deviant rats that turned to cannibalism of immature, unprotected rats. With the exception of the normals, these rats characterized the dense areas.

Abnormal female behavior also appeared in the dense areas. Calhoun's females built sloppier nests

as density increased, and finally stopped nest-building altogether. They also failed to carry their litters from danger; instead, they scattered them on the floor of the cage where wandering males killed them. Few litters survived. Although pregnancy rates were normal, between 80 to 96 per cent of the newborn died before weaning; in less dense pens 50 per cent survived.

At the termination of the experiment Calhoun separated out the eight healthiest males and females in the prime of their life. In spite of no longer living in dense populations they produced an abnormally low number of young, none of which survived to maturity.

Dr. Calhoun also has experimented with mice. He put eight mice into an eight-foot-square cage; in two years the population increased to 2,200. When the population had increased to about 600, 14 social groups had been formed. Young mice were ostracized from all these groups, and so they formed a rejected huddle in the middle of the cage. Their rejection brought violence; they wanted to be alone and attempted to reduce any social contacts by biting and fighting.

As of March 1972 more than 600 mice had died in the experiment and not one newborn mouse has survived since March 1970. In March 1972 the population had been reduced to only 300 mice, which suggests that the reproduction of the colony had come to a halt.

A group of mice share their experimental crowded quarters with Dr. John Calhoun of the National Institute of Mental Health. Crowding created social disorders, Dr. Calhoun found, and even normal males went "berserk" at times and attacked their neighbors. The eight-by-eight-foot habitat was well provided with food, water, and "apartments." At its peak, it housed 2,200 mice.

Photo by Y. R. Okamoto

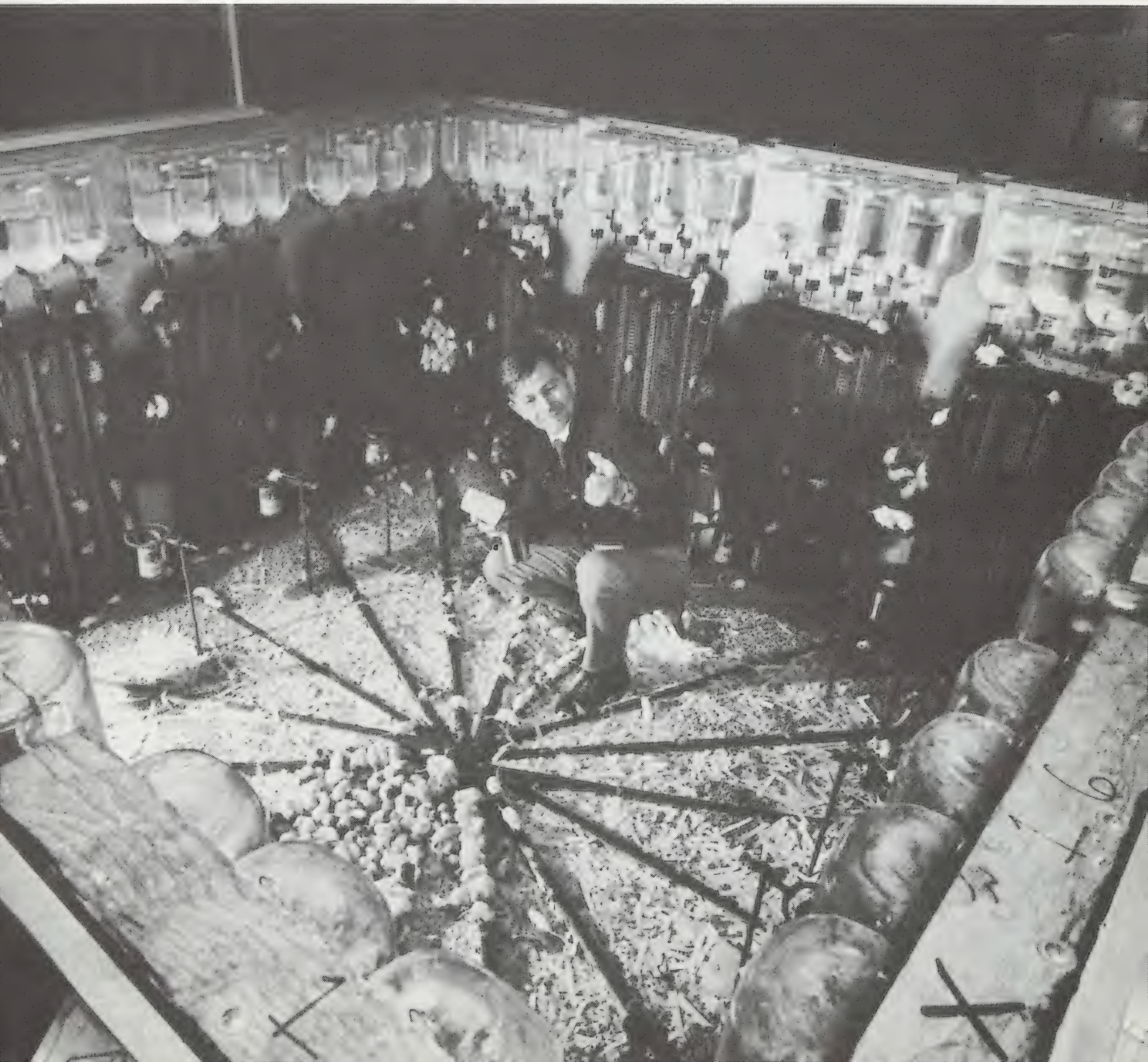


Photo by George Schaller

It is known that lions will attack their young at times, often when food is scarce. This condition can be aggravated in crowded situations.

Squeaks are silenced

Apparently, there were just too many mice in the colony to permit reproduction. Acts of sexual and social intercourse were rarely completed before interruptions occurred. The acts of eating and drinking were the only successfully completed behaviors. The young mice never learned to fight or to mate. Interruptions from other mice never let the behavioral sequences get started. With the loss of social interaction, most matured into "passive blobs of protoplasm, physically healthy but socially sterile," wrote Calhoun. With the social breakdown came a loss of squeaking and noise, so finally a silence prevaded the normally noisy colony.

These results reflect the lessons that have been learned from other experiments by various biologists working with rodents and other mammals. Accordingly, the following abnormal "crowded" behavior may apply to some extent in all mammals – including, perhaps, human beings.

Emigration – The maintenance of a personal "territory" is referred to as "territoriality" and is characteristic of many vertebrates and invertebrates. Territoriality is a basic spacing-out mechanism. A larger, non-defended piece of real estate that is used for hunting food or mating is characteristic of many mammals and is called the "home range." When population density increases, the size of the territory or home range decreases. As young are born and mature, they search for un-

Photo by George Schaller

Among primates, such as baboons, aggression is uncommon in the wild but increases greatly in captive groups, where crowding puts the animals under stress.

used territory; if none exists because of crowding, the young tend to emigrate. If caged, they attempt to escape. In the wild, emigration is possible. Thus, the most subordinate animals, usually the youngest, are the first ones forced to leave the preferred habitat. They are pushed out through aggressive encounters with dominant, older adults. The emigrants can find a new preferred habitat, between existing territories of other residents. If no preferred habitat remains, they must go to a nonpreferred area where lack of cover or food may allow predators, starvation or exposure to take their toll.

Emigration is the first response to crowding; just what individuals emigrate and what their characteristics are, is now being studied by several workers. Garret Clough, who studied lemming movements in Norway, regards migration of lemmings as due to crowding and the resulting intolerance between individual lemmings. Aggressive behavior and decreased food supplies stimulated lemmings to move in great numbers to locations unsuitable for overwintering, where many died.

Aggression – Studies on confined populations, whether rodents, red deer or primates, indicate that as density increases, aggression and fights also increase. In the early stages of such studies, when density is low, individual territories are maintained. These are recognized by the animals, and fighting is kept to a minimum. At a specific population density, however, territoriality disappears, and as the animals begin to range freely throughout the colony, fighting increases.

Emigrate or fight

Dominant-submissive relationships begin to form. This occurs in the laboratory even when such relationships are not natural in the wild. Social mammals such as wolves, hyenas, and jackals often have a well-defined social order in the wild. However, mammals that maintain territories in the wild usually do not have such social hierarchies. Yet, when these are brought into the laboratory where emigration is impossible, territories disappear and the dominant-subordinate "social pecking order" evolves. Continual fighting is necessary to maintain this order. Although the newborn are immune from such fights, as they mature they must fight since they cannot emigrate, as in the wild. Thus, there is a continual new source of social combatants that must fight or remain subordinant.

Garret Clough compared lemmings in the field and laboratory in Norway. He found that antagonistic encounters were much more intense in the laboratory than in the field. Red deer fight when crowded, the stags killing young and strange male adults. Among primates, such as Patas monkeys, vervet monkeys, and baboons, aggression, uncommon in the wild, increases greatly in captive groups. It has even been found that wild monkeys, if fed artificially at a specified feeding station in the wild, increase their aggression and induce unnatural dominant-subordinate relationships.

Mating behavior – Mating behavior in most species of vertebrates occurs in a series of specific steps. This sequence is an inherited process; if any step is interrupted, all the following steps will be missing also, and the mating will not occur. I personally observed this in my colony of rats where females and males continually responded to mutual signals. An excess of males attempting to copulate with a female inhibited her ability to mate successfully. Other studies show that when a strange male is introduced into the cage of a pregnant female, she often aborts. Also, there is evidence that when a wolf pack gets to a certain size, successful matings drop as a result of interruption. Low-ranking wolves are harrassed by dominant wolves so they decrease reproduction attempts. Food can also affect sexual behavior; rabbits,

sheep and lions are known to reproduce less when dense populations lead to less food.

Fertility – What effect does high density have on the success of the ensuing pregnancy, birth and early life? In laboratory studies, crowding decreases litter size, decreases rate of pregnancy and increases death rates of newborn mice. If more space is provided to the mother, these symptoms disappear after awhile.

Food and fertility

Similar symptoms have been found in nature. The number of fawns per doe decreased in a deer population that grew from 200 to 5000 in seven years. After 1600 deer were harvested, the fertility increased. The fertility of rabbits also reflects their population density: litters were larger in a sparse population than in a dense population. Rabbits are known to reabsorb litters *in utero* to control their fertility in bad times. Poor nutrition, a possible result of crowding, may affect the size of litters. Sheep have more twins, triplets and quadruplets when there is more food. The lynx, lion, fox, marten and probably most mammals demonstrate higher fertility when food is more plentiful.

Maternal behavior – Under crowded conditions mothers attack their young, destroy their nests, construct inadequate nests, and destroy the litter. Attacks on unprotected new litters by other adults of both sexes leads to high mortality of the newborn. Crowding increases the social contacts which, in turn, increase the chances of disrupting normal maternal behavior.

Just how much this behavior in the laboratory reflects the behavior in dense populations in the field is unknown. One noted ecologist, Dennis Chitty, studying mice in Wales, found high mortality of juveniles and concluded that the adults were responsible. We know that various species, such as rodents, rabbits and lions, attack their young at times. It occurs more often when food is lacking, a condition that can be compounded by crowding. Thus high density of populations leads to an increased disregard for the newborn.

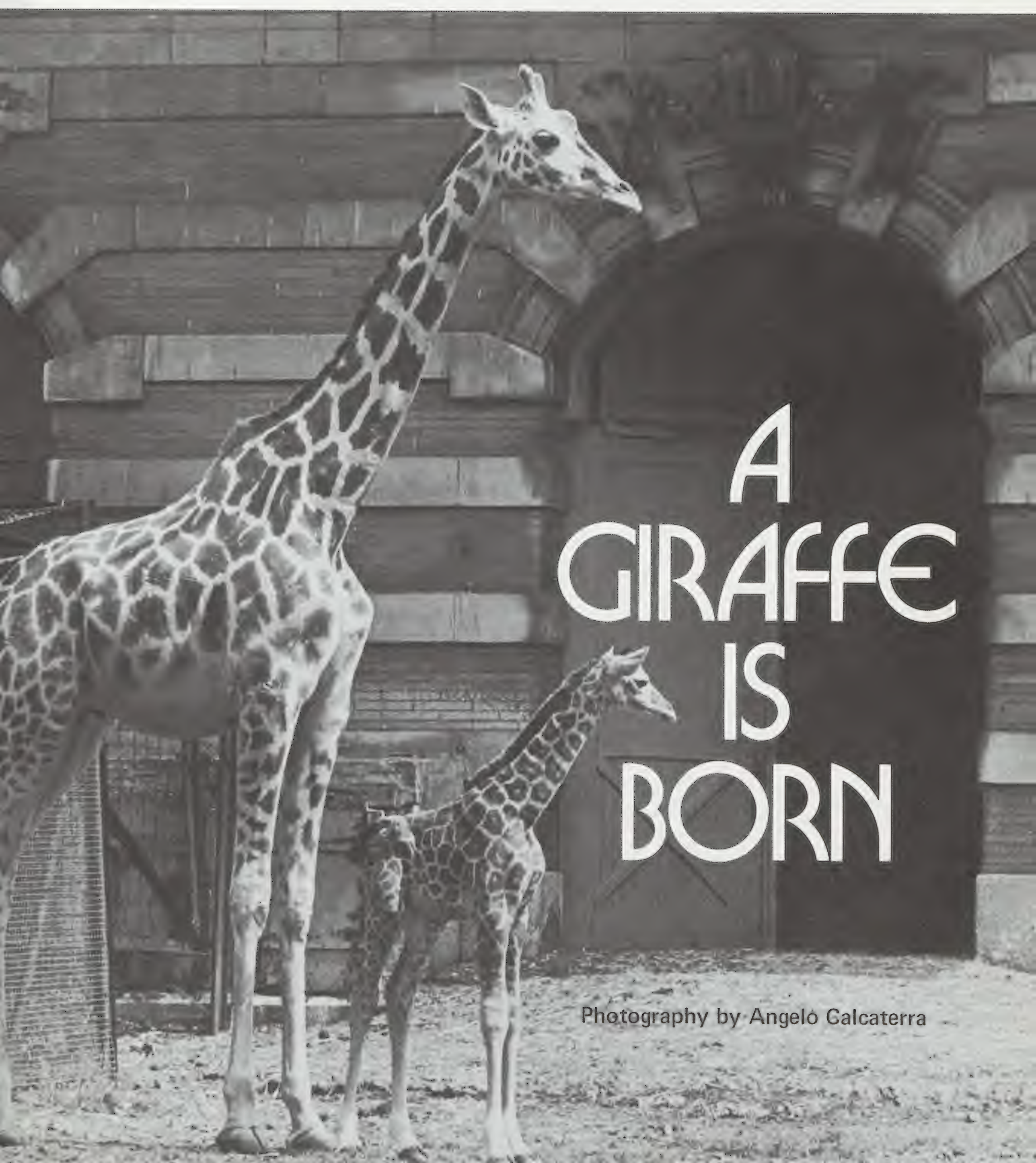
Crowding can lead to malnutrition, which in turn, reduces the growth of individuals, be they rodents, seals, lions or men. New Zealand deer, red deer, and white-tailed deer are all smaller where food sources decrease, as is the horse and other mammals. If extreme malnutrition or starvation occurs, it is primarily the young that die because they cannot compete for available food. Thus, even where mating is successful, the litter often dies from an inability to obtain food.

Few adults of any species actually die of starvation. Regulation of numbers always takes place in advance of such an emergency. This regulation may, however, be related to food. For instance, I kept two captive weasels for over six months in a cage. They slept side by side, and one would have concluded that "they were very good friends." One day, through an oversight, they were not given fresh meat; the following day one was found dead and half eaten. Although this appears to be pure and simple socially induced mortality, it was precipitated by a lack of food.

Although food is an overwhelming factor in population growth, the effects of crowding also need to be studied. What are the social, behavioral, and physiological effects of dense populations? When is a population too dense? How does population growth stabilize? Many of the consequences of crowding in mammals have yet to be revealed. When these are uncovered, they may improve the quality of life for both man and beast on our crowded planet.

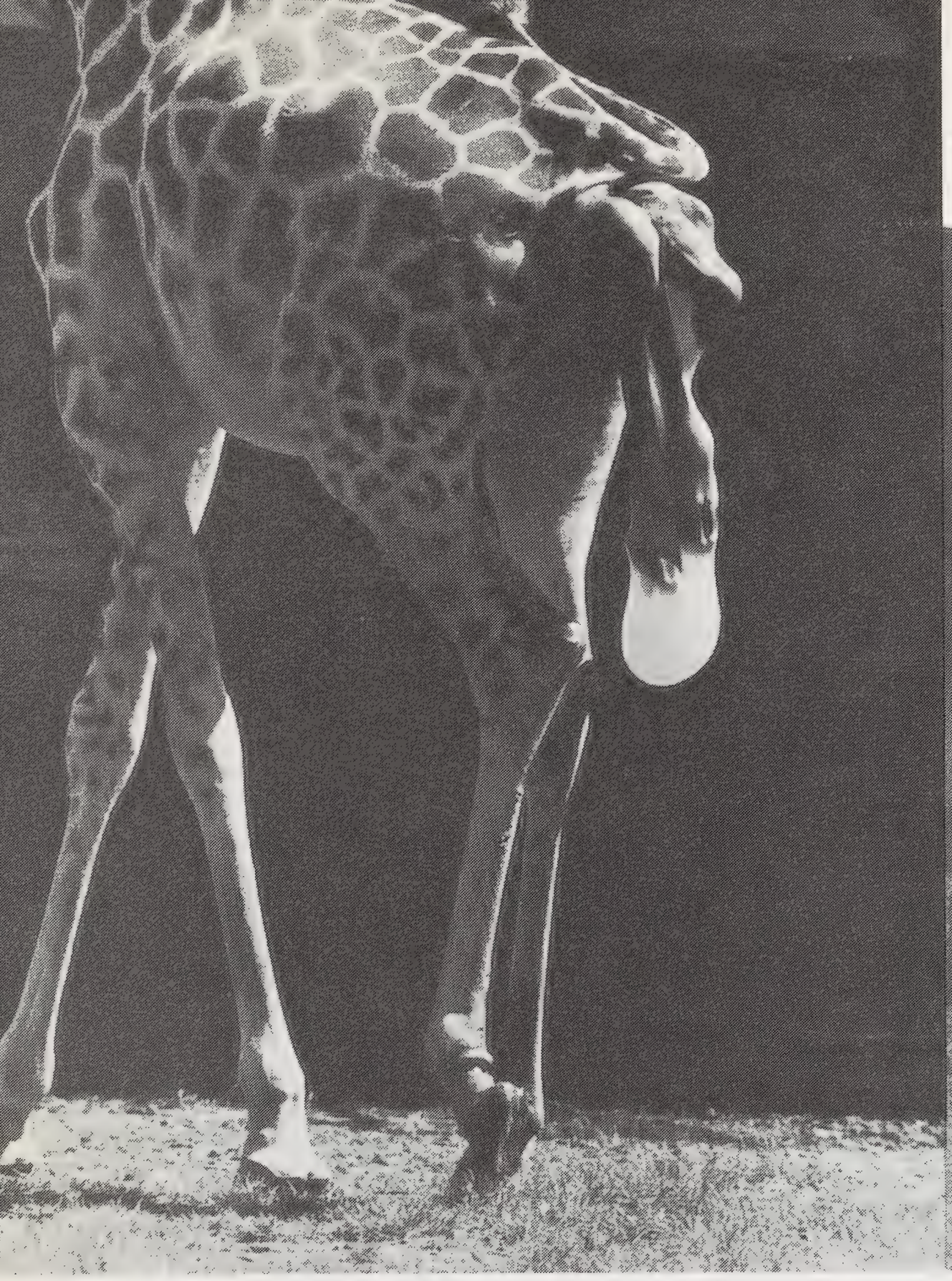
An animal is born at the Bronx Zoo. And no matter how many others of its kind have been born in captivity before, any animal birth is an important occasion. Such an event occurred at the Zoo September 3, when the birth of a baringo giraffe was photographed by Angelo Calcaterra, a member of the New York Zoological Society. The female giraffe had been restless all morning and was pacing back and forth in the yard outside the Giraffe House when the birth began. The forelegs of the baby appeared first, soon followed by

A female baringo giraffe introduced her new son to visitors at the Bronx Zoo shortly after its birth September 3. The youngster was the second addition to the Giraffe House this year; in June, a male had been born to the Zoo's other female baringo giraffe.



A GIRAFFE IS BORN

Photography by Angelo Calcaterra



◀ (1) The youngster emerged from its mother legs first, followed by the head.

▲ (2) The mother dropped the baby inside the stall on the straw-covered floor.

the head. The female then moved inside the building, where the calf was dropped in the deep straw that covered the floor. The new mother began to lick and clean the youngster assiduously. The calf, a male, finally stood up, after several shaky attempts, and wobbled uncertainly to its mother. Assisted by nudges of its mother's head, the baby began to nurse. The entire procedure took about one hour, and it was not long thereafter that the youngster was encouraged outside by its mother and introduced to the waiting curators and keepers.

But a more exciting introduction soon occured when the new baby met another youngster, a male calf which had been born to the Zoo's other baringo female on June 18. The older calf approached the new arrival, a nose-to-nose greeting was exchanged, and the new-found friends proceeded to romp together around the yard.

The baringo giraffe *(Giraffa camelopardalis rothschildi)* is native

(5) After a few shaky starts, the youngster finally stood on its feet. ▼

(3) Moments after birth the baby raised its head. ▼

▲ (4) The mother gingerly began to clean its offspring.

(7) Assisted by its mother's nudges, the baby began to nurse for the first time. ▼

An interested spectator was the other female affe, which watched from an adjoining stall.

(8) An hour after its birth, the new baby was outside in the yard, where it received a nose-to-nose greeting from another youngster. ▼

Continued from page 17

to northwestern Kenya and Tanganyika in Africa. Although the giraffe was known to the ancient Egyptians as a captive animal and to the Romans at least during the reign of Julius Caesar, it was not until the nineteenth century that it became fully established in European zoological gardens. A pair of giraffes, the first to be received by the New York Zoological Society, arrived October 17, 1903, and since that time, the Bronx Zoo has never been without representatives of the group.

▲ (9) Introductions completed, the new-found friends cantered around the yard, under the watchful eyes of their mothers.

by William D. Fitzwater

Weaver Finches of Hispaniola

These dexterous nest weavers, introduced from Africa, have ravaged the palms and rice fields of their Caribbean island home in the New World.

The stinking, sluggish wooden ships plying the "black ivory" trade between West Africa and the colonies of the New World carried other captives besides slaves – brightly colored African birds that had also been taken from their native shores. Doubtless many bird species were brought over that never survived and reproduced, but the descendents of one species, the "village weavers" *(Textor cucullatus)* of Africa, are today well-established on the Caribbean island of Hispaniola. In Haiti they are called "Madame Sarah." In the Dominican Republic, which shares the island with Haiti, they are known as "Madam Saga" or "sigua haitiana" (little bird from Haiti). They have become established only on Hispaniola.

The written history of Madam Saga in the New World begins in dusty diaries of the 1700s; historian Moreau de Saint-Mery wrote of the variety of Senegalese birds caged in the aviary of a French plantation owner near Cap Haitien in 1783. When they escaped their bondage is not known, but a free-living colony of the birds was first reported around Port-au-Prince in 1917. The first complete study of the avian fauna on the island was made around 1927 by the Smithsonian ornithologist, Alexander Wetmore, who found colonies of the bird established around Port-au-Prince and in the Artibonite River Valley as far east as the Dominican Republic border.

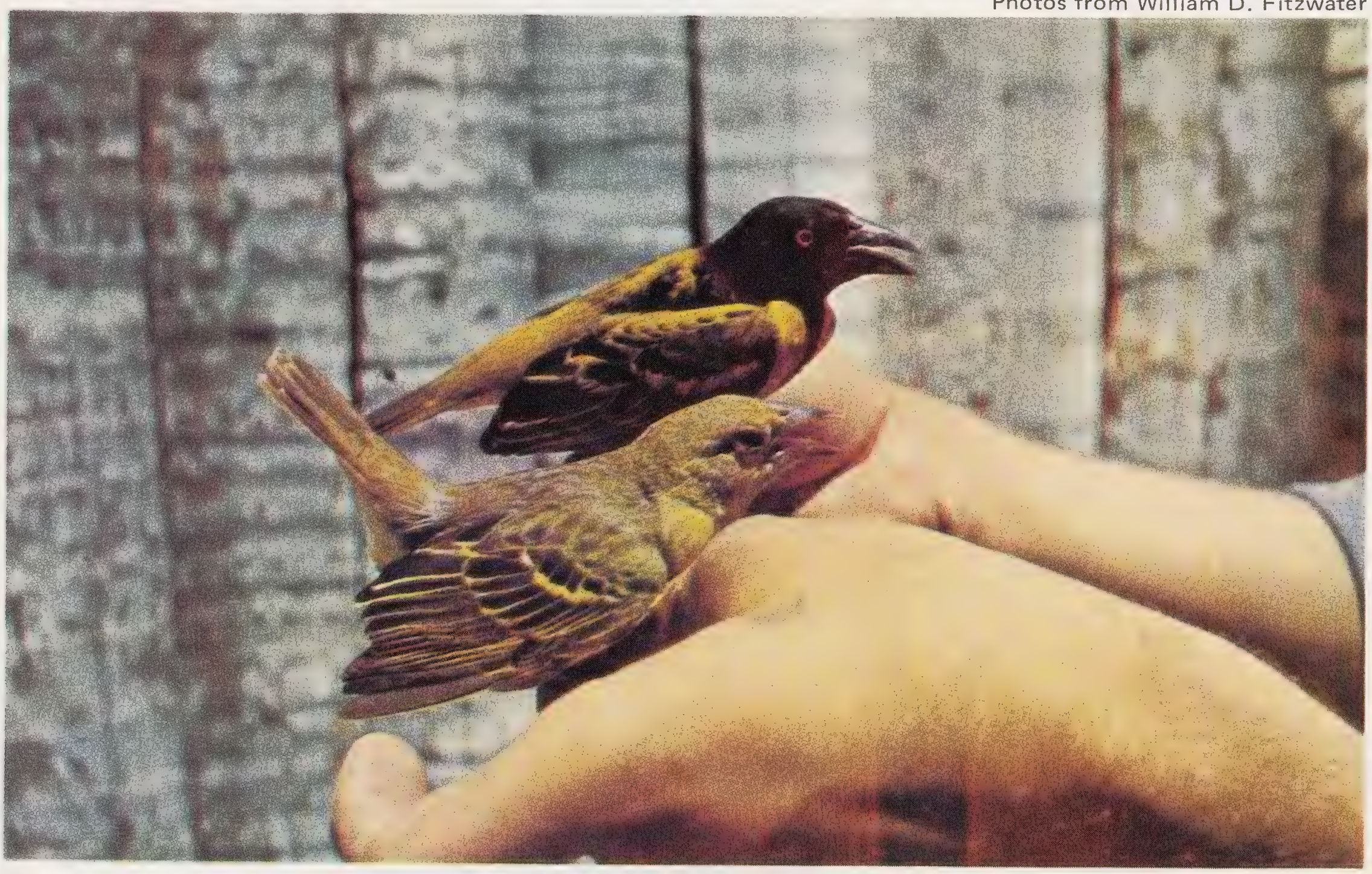
William D. Fitzwater is with the publications branch of the Environmental Protection Agency in Washington, D.C. Field assignments for the United Nations have taken him to Hispaniola and to India, where he studied the desert gerbil.

Finches find a home

Four years later, Wetmore reported that the numbers of this weaver finch had " . . . increased considerably since the original observations." Professor Marcano of the University of Santo Domingo found the bird had moved eastward to Santo Domingo by 1958. Three years later it was established on the eastern end of the island near Higuery. Thus in the space of half a century, this little African native had found the tropical lushness of the New World entirely to its liking. Too much so. Within the last decade, it has become a

The weaver finch family is native to the Old World, but one species, Textor cucullatus of Africa, was transported to the New World during the days of the slave trade. It has become established on the island of Hispaniola, where it is now a serious pest. The male of this species has a bright yellow body and black head, with olive-colored wings; the female is lemon-yellow in color.

Photos from William D. Fitzwater



The weaver finches of Hispaniola prefer to build their nests in palm trees, at the source of palm leaflets, their basic weaving material. The palm fronds (above) and those in the village (left) have been stripped down to their central stems.

Built by the male to court the female, the nest is made of tightly woven and knotted plant fibers. The completed nest (above) is then "furnished" by the female in preparation for egg laying.

A local bird trapper makes matchete cuts in the trunk of the breadfruit tree and collects the white latex which oozes from the fresh cut. Mixing the latex with castor oil and wood ashes, he smears the resulting bird "glue" on branches that will be placed in the field to trap the weaver finches.

serious threat to the agricultural economy of two countries that can little afford the luxury of this colorful avian thief.

Hispaniola is a small chunk of land in the tranquil Caribbean, but its 30,000 square miles contain two very different cultures. The island developed into black, French-Creole speaking Haiti on the west, and the white, Spanish-speaking Dominican Republic on the east. The two countries have been at odds with one another over the years, but the depredations by Madam Saga have made both seek help from the United Nations.

Madam Saga is actually a pretty little bird resembling our handsome Baltimore oriole. The male has a bright yellow body with dark olive-colored wings. His head is capped with a somber black hood. The red iris of the eyes gleaming out from beneath the hood along with the strong wicked bill give him a somewhat sinister appearance. The female is a lemon yellow and lacks the black hood.

Skillful weavers

The birds belong to the avian family of weaver finches (Ploceidae). This group was originally confined to the Eastern Hemisphere, but meddling man has moved some species of them around the world – the classic example being the English, or house, sparrow. While the sparrow is a weaver finch, its relationship is derived from its anatomical structure rather than its ability at "weaving." The sparrow throws together an untidy collection of twigs and feathers and calls it a "nest." Madam Saga and most of the other weaver finches display a nest-building dexterity that is the pride of the avian world. In these species, the male weaves and knots long plant fibers into an intricate nest structure that is an architectural gem.

The nest consists of two compartments. Both are completely domed over, so that the birds fly up into a vestibule entrance before reaching the nest compartment containing the young. The foundation is laid when the male weaves a ring of fibers enclosing several branchlets or leaflets. This attaches the nest firmly to the tree. The fibers are so tightly woven and knotted in this ring that it is difficult to tear them apart by hand. Using this ring as a work platform, the male anchors other plant fibers to it. He then pushes and shapes these out to form twin compartments on both sides of the ring. The compartment that is completely enclosed will contain the nestlings, while the other becomes the vestibule with its entrance facing downward.

The weaving male is the picture of industry as he pushes and pulls the fibers into the desired shape. He often hangs by his heels, flapping his wings to keep his balance as he puts the finishing touches on his masterpiece. While palm leaflets are the preferred basic weaving material, he will use similar fibers from sisal, maize, and sugar cane leaflets. Palm trees are the preferred sites, as this puts these building blocks close at hand. However, he also likes the *bayahonde* (mesquite: *Prosopsis juliflora), roble* (Haitian oak: *Catalpa longissima),* and *saman* (an African import: *Samania saman)* as colony sites. I saw one nest in a lone pine tree

(Pinus occidentalis); the long needles were cleverly woven into the nest.

Where other trees are utilized as colony sites, the birds often fly a quarter-mile or more to obtain the long fibers (such as palm leaflets) that are not available on the colony tree. In the early morning such colonies seem like busy airports, as lines of male birds fly out to the building supply yard and return with long fibers streaming behind them. Occasionally, hijackers may grab the free end, causing a tug-of-war. Often, a struggling pair will find themselves hung up over a branch, with both birds flapping in the air until the fiber breaks or one of them lets go.

The males are quite single-minded in their nest building – it appears as if they even hesitate to take time out to eat. I watched one male build a nest in three days as he worked from dawn to dusk.

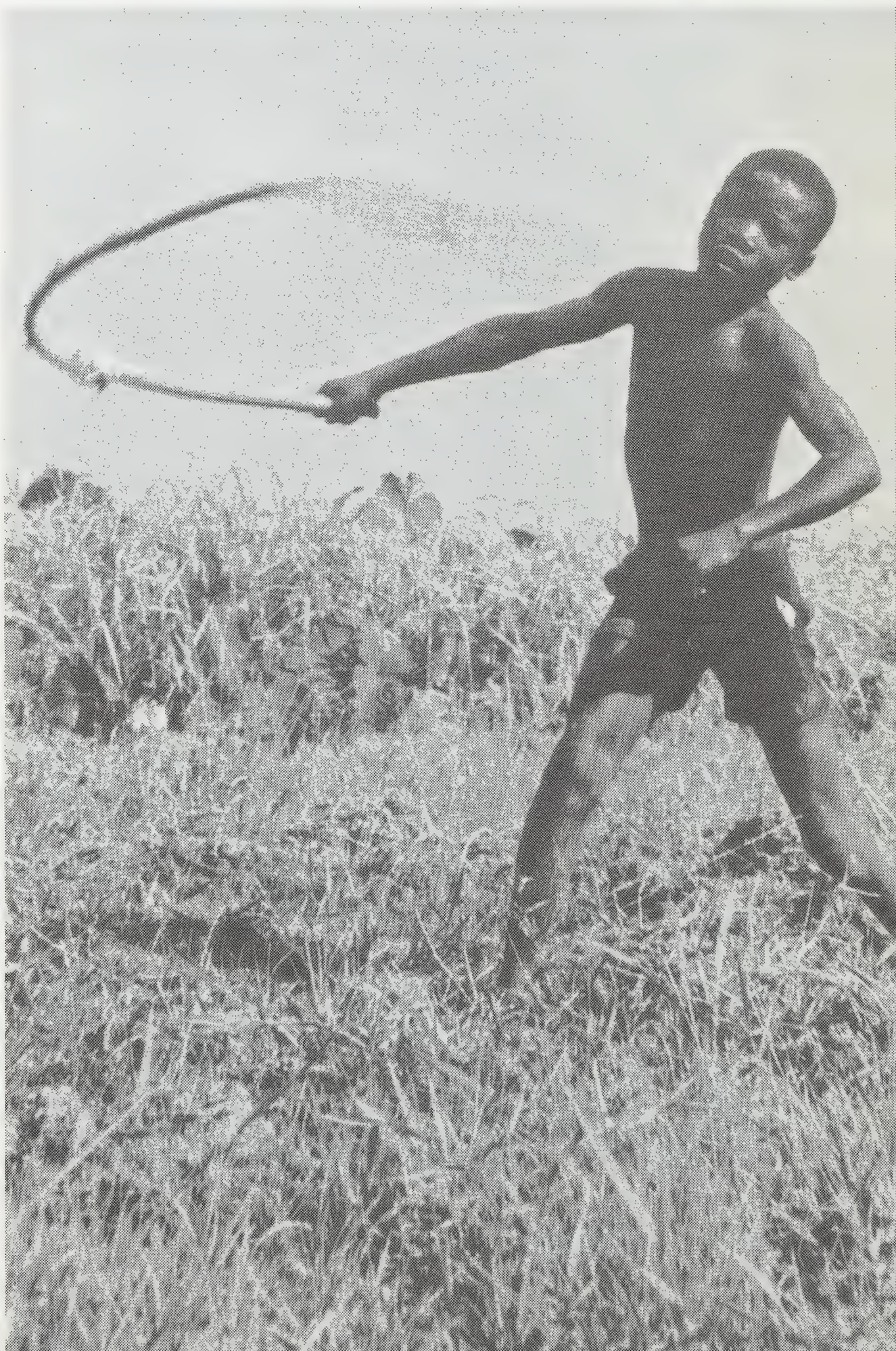
Females furnish nest

Once the nest is built, the male takes a stand nearby and attempts to entice a prospective mate into his lair. If he is successful, the female is then responsible for bringing in the "furniture" – numerous layers of soft seed panicles and grass stems packed (not woven) into a tight, insulated cup to hold her two eggs. If the male is not successful, his boundless energy drives him back into the building business again. I watched one frustrated weaver attack his house and completely demolish it in several hours. He even flew down to the branches directly underneath the nest to free some fibers that had fallen there. Then, despite the fact that some of the old nesting material was still partially green, he started the long trek to bring in new building blocks for another home. Another male worked simultaneously on three nests. Apparently, outside of feeding and fighting with the other males, nest building is the main outlet for the male's energy.

Unfortunately, few objective studies have been made on the ecology of these interesting birds on Hispaniola. The African reports indicate that they may raise two or more broods, depending upon their geographical location on that continent. As I did not have the opportunity to study the yearly cycle of the species in Hispaniola, I am not certain just how long or how productive the breeding cycle is. Egg laying started in May and was continuing in July when I left the island. This seems to coincide with the rainy season, which is also true in the ancestral lands, as food is most plentiful at that time. There is a second rainy season in the fall and there are two rice crops, so there may be a second period of breeding on Hispaniola. The weatherproof and predatorproof nests should assure that the broods, though small, are successfully fledged; the biotic potential of the species would seem limitless.

Evaluating crop damage

The actual damage done by vertebrate pests is notoriously inaccurate for any country. The agriculturist usually blames his crop losses on some easily recognized factor, preferably one over which he has little control. Thus, sighting bird flocks in the field is generally taken as evidence of damage. For example, I heard numerous complaints about the *pecheur* (glossy ibis: *Plegadis falcinellus)* in Haiti. These conspicuous birds spend most of their day in the rice paddies. Some growers felt they



A young Haitian "bird-watcher" patrols a rice field by snapping a long, home-made whip over his head in an attempt to scare away the marauding finches from the crops.

were a more serious problem than Madam Saga. While ibises may cause mechanical damage, particularly to young plants, their diet supposedly consists mainly of mollusks and other invertebrates rather than rice.

On the other hand, those who are not directly affected economically refuse to believe that the pretty weaver finches can do any appreciable damage. As in most cases, the truth ususally lies somewhere in between the two extremes. The governments estimate that the annual loss to the rice crop by these pirates lies between 10 to 20 per cent. The larger growers, particularly those on the eastern side of the island who are just starting to encounter the birds, feel the damage is minimal. Smaller growers near colonies of birds can and do find their entire crop destroyed and the family faced with starvation.

That the birds do concentrate on a maturing rice crop to the exclusion of other foods was found to be a fact. Of some 50 birds collected and examined, their digestive tracts were found to contain from one to 42 grains of rice, averaging about 14 kernels per individual. No other food items were found. As rice is subject to damage for a period of 30 to 45 days from milk stage to harvest, the total consumption by a colony of considerable numbers would be a serious drain on any grower.

Although the main complaints were for rice, which is the main staple in the diet of both countries, Madam Saga does not ignore other crops. All grains, such as maize, millet, and milo, are attacked. Singl Golteus, Haitian Government Supervisor in the Artibonite Valley, states: "In one year when the rice and millet crops failed, Madame Sarah moved up into the mountains of the Gonaives District and attacked peaches at elevations around 1,250 meters." The birds are also known to damage bananas, oranges, papayas, guava, mangoes, beans, and peas. While they do not attack coconuts, their nest-building activities completely defoliate and eventually kill the palms.

Patrolling a pest

Attempts to control these depredations range from the very primitive to the highly sophisticated. As the going rate for "bird-watching" was 50 cents per day plus a ration of rice, this is the commonest method. The "bird-watchers" patrol the fields from dawn to dusk attempting to scare the birds away. In Haiti they use long, home-made whips. These they snap over their heads as they pass down the rows making sharp cracking noises like a small firecracker. As you watch the birds flitting tantalizingly ahead of the beaters to the end of the field, and then twisting back over their heads to settle down in the other end, you get the impression the birds think it's a game. The farmers say that it takes four men patrolling every 2.5 acres to keep the birds moving. Further they admit that the actions of the bird-watchers only cut losses to one fourth of what they would be without this "protection."

Latex glue traps

Scarecrows, mainly white plastic fertilizer sacks hung up on stakes above the paddy fields, are seen in many fields. It is doubtful if anyone, including Madam Saga, takes these seriously. There are a few primitive traps and snares, but these are not used to any great extent against Madam Saga. Probably more reliance is laid on the use of bird "glues." These are made from a mixture of breadfruit latex, castor oil, and wood ashes. In the hands of native experts, they seem an effective means of supplying birds for the caged bird market or the pot. Incidentally, a rumor was started – probably by the rice growers – that *Madam Saga con arroz* had aphrodisiac powers. The subsequent demand that arose for the dish did make some inroads on local numbers.

The ineffectual bounty system has also been tried. Boys are paid three cents in some areas for the nests they turn in. But as mentioned previously, the house-building fervor that assails the males soon bankrupts the treasury without too seriously affecting the population.

An important method is shooting the birds on their roosts with air rifles. Gunpowder is hard to come by, as the authorities fear it might be used for political rather than agricultural purposes. In the realm of more advanced technology, attempts have been made to spray bait crops with dangerous insecticides, but the limitations of this approach are all too evident.

The case of the weaver finches of Hispaniola clearly supports the thesis that a thorough study of the life history of a "pest" species must be made before effective and economical controls can be devised. Field biology seems a luxury to a developing country with limited resources. But the basic biological factors – the reproductive cycle, movement patterns, social structure of the colony, food, environmental, and geographical requirements – must all be determined before a sound control program can be evolved.

Photos from Joseph W. Shaw

TO SAVE A SALAMANDER

Isolated by time and space in a threatened habitat, the Jerez Mountain salamander clings to survival.

High on the forested slopes of the Jemez Mountains in northcentral New Mexico, a tiny, three-inch salamander is facing its most crucial survival test since the Wisconsin glacier receded 12,000 years ago. Separated from its nearest relatives by nearly 600 miles, the Jemez Mountain salamander *(Plethodon neomexicanus)* survives tenaciously in its last stronghold, the heavily timbered slopes of an extinct volcano in the Santa Fe National Forest. While timber interests hungrily view the creature's habitat in terms of board feet, scientists from the University of New Mexico press ahead with research on its specific environmental requirements in an effort to forestall the extinction of the species.

This salamander was first discovered in 1924 on the cool, forested rim of Valle Grande – an immense volcanic caldera in the Jemez Mountains. Incorrectly identified as just another example of a related species, a specimen collected dust on a shelf in the United States National Museum for a quarter of a century – until two herpetologists, R. C. Stebbins and W. J. Riever, exhumed the tiny creature in 1949. Based on the museum's specimen and their own collecting in the Jemez area, they established its identity as a new and distinct species.

Biologists believe the salamander was left behind in its high isolated "island" of cool, damp climate when the Arco-Tertiary forests, which covered the ancient southwest, began to disappear at

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Joseph W. Shaw has stalked the salamander in the forested regions of New Mexico. As a photo-journalist, he has worked to stir public interest in the preservation of wilderness areas.

the end of the last Ice Age. The problem now confronting the U.S. Forest Service and UNM researchers is to make sure the activities of man do not make life unliveable for this lungless salamander as it clings to existence in its sole remaining habitat.

Although apparently abundant within its restricted range, the Jemez Mountain salamander is being treated as a rare and endangered species in the Tesuque District of the Santa Fe National Forest, which includes within its boundaries the salamander's entire known distribution. But ever-increasing national demands for lumber may create a conflict of priorities. Forest Service officials for the Tesuque District said that nearly 2,000 acres were withdrawn from a recent timber sale to preserve a portion of the salamander's habitat while awaiting results of UNM's study. They estimate the area contained nearly 1,500,000 board feet of lumber.

Logging a threat

Wendel Gore, district ranger, and frequent visitor to the primary study location, explained his position: "We're interested in protecting the little fellow," he said. "That's why we're interested in this study – to determine how logging practices should be altered in the salamander area, or if they need to be altered at all."

While lumber interests continue to push for increased allotments in the Jemez area, a graduate student from the University of New Mexico presses ahead with research which could lead to permanent protection for the salamander. Steve Williams, graduate student from UNM's Department of Biology, probably knows as much about the Jemez Mountain salamander as anyone. He seems right at home charging up and down the forested slopes, overturning rocks and logs in search of his elusive quarry.

Williams began his work with salamanders under severe conditions. As a sophomore at Rutgers, he landed a job as a work-study student and research assistant for Dr. James D. Anderson, ecologist and professor of zoology at the university. Williams had never before seen a salamander. Dr. Anderson departed immediately on a collecting trip to Mexico, leaving the newly-hired Williams in charge of 60 adult salamanders and eight larvae. Dr. Anderson's parting words were that it would be a stroke of luck if half the salamanders lived. To complicate matters, he began sending new specimens back to his laboratory as soon as he reached the collecting area. Williams sped through volumes of salamander lore, and in one week logged over 80 hours tending his charges. At the end of the collecting trip Dr. Anderson found that mortality had been held to a mere two per cent.

Search in the mountains

Williams began his University of New Mexico research in early June, 1970, under the direction of Dr. William Degenhardt of UNM's Department of Biology (with funds from a National Science Foundation grant). After a period of intensive library research on closely related salamanders (very little has been published on the Jemez Mountain species), he moved into a cabin overlooking the grassy, pine-rimmed basin of the Valle Grande and initiated his field work.

The cabin, owned by UNM, is hidden in a grove of pine and aspen high along the Valle Grande's south rim. Williams was isolated for days at a time without electricity or running water, but in retrospect he said he didn't mind the inconvenience. "It

got lonely up there after a while," he said, "and monotonous. I carried water up from a spring in the valley to break routine, and a Coleman lantern kept me company in the evening."

Williams would often climb alone late into the night among the fallen trees and underbrush on the steep slopes above the cabin, systematically searching one of several salamander "localities." When he found one of the fragile amphibians, usually under a rock or fallen log, he recorded significant environmental data, such as soil temperature and moisture content, altitude, and prevailing weather. He then marked the location and returned the salamander to its habitat.

Williams intends to subject the collected data to computer analysis in determining the salamander's specific environmental requirements. Another phase of Williams' research project involves mapping salamander distribution patterns throughout the Jemez Mountains. Collectors have recorded spot sightings in the vicinity of the caldera since the salamander's "rediscovery" in 1949, but until now, no attempt has been made to determine the extent of the animal's total population. In one 11-acre study location, Williams estimates there are nearly 6,000 individual salamanders. Although the salamander seems to thrive under ideal conditions, these "ideal" conditions are in fact critical for its reproductive cycle — the factor most important to the survival of the population.

A fragile habitat

Salamanders belong to an ancient class of animals called amphibians (*amphi,* two; *bios*, life), and although many species live on land, the class over-all is poorly adapted to terrestrial life. Like their cousins the frogs and toads, salamanders were short-changed in the body covering department. They lack feathers, fur, or scales for protection, and lose body moisture rapidly through a thin layer of porous skin. Many of the terrestrial forms, including the Jemez Mountain species, lack lungs entirely. They get oxygen primarily through their skin, and suffocate if their surroundings become too dry.

The Forest Service, charged with overall resource management for the area, is particularly interested in finding out how logging practices would affect the salamander's habitat. "It seems clear at this point," said Williams, "that the salamander requires the cool, damp forest-cover found on north-facing slopes. It's a fragile environment which would be destroyed by even selective logging."

Williams explained that evaporation and drainage occur at greater rates on open surfaces and south-facing slopes than on north-facing slopes or in sheltered canyons. Sunlight, hitting the south slopes, causes runoff, while snow on the north slopes lasts longer and melts gradually, releasing more moisture to the soil. Increased moisture retention encourages increased vegetation, which in turn retains more moisture.

Williams' research has recently expanded to include the salamander's reproductive ecology. This involves sectioning the reproductive organs of both males and females captured at regular intervals throughout the year, preparing the sections as microscope slides, then correlating the slides with temperature and precipitation records for the area.

Moisture and mating

"My guess is that mating takes place between June and July," said Williams, "and that eggs are laid and young hatched during the summer rainy season." He explained that male salamanders produce sperm as late as October. The sperm is stored over the winter in the male's body until the spring mating season. "There's also the possibility of two fertilizations per year," he said. "It occurs with other salamander species." Although not ruled out as a possibility, more than one fertilization per year seems unlikely for *P. neomexicanus.* Summers are brief at altitudes over 7,000 feet.

The United States has more salamander species than any other area — the southern Appalachian Plateau is probably the salamander capital of the world with over 30 species. Salamanders have been around for over 100 million years, longer even than frogs, and their immediate ancestors appeared 300 million years ago.

But for all their eons of evolution, these tiny relics of another age face their most crucial survival test in the time of modern man. As forests fall to the bulldozer and chain saw to satisfy man's desire for land and raw material, salamanders go about their business on borrowed time. Under Forest Service protection, the Jemez Mountain salamander may be able to borrow a little more.

esearcher Steve Williams records the soil
oisture content and temperature where a Jemez
ountain salamander was discovered (far left).
his data, along with population and size figures,
elds a profile of the salamander's environmental
quirements. An immature salamander is shown
top left and a mature individual below.

Reports

NYZS photo

The snow leopard, shy resident of the snowy heights of the Himalayas, is generally considered the most beautiful of the cats.

RARER THAN THE ABOMINABLE SNOWMAN?

The snow leopard is a shy animal. At the Bronx Zoo, visitors may easily observe the four adults that are on exhibition, but they will have to be patient if they want to see the two snow leopard cubs that were born at the Zoo on May 21. The youngsters, reportedly females, are rarely seen, although they do come out to play, usually in the morning and late afternoon.

The casual zoo-goer, passing the snow leopard exhibits on the outside of the Lion House, might never notice the smoke-gray eyes peering out from the den. If a visitor pauses, however, he might be rewarded with a sight of the two frisky cubs. Observing snow leopards requires patience – whether high in the Himalayas or at the Bronx Zoo.

The snow leopard has seldom been observed in the wild. Adapted for life in the high mountains, it inhabits the great ranges of Central Asia. There is one record of only 12 sightings over a period of more than 20 years. On one occasion, a cameraman on an expedition to find the Abominable Snowman reported seeing a snow leopard in the distance, some 14,000 feet high in the Himalayas. Indeed, more sightings of Abominable Snowman may have been reported than of snow leopards.

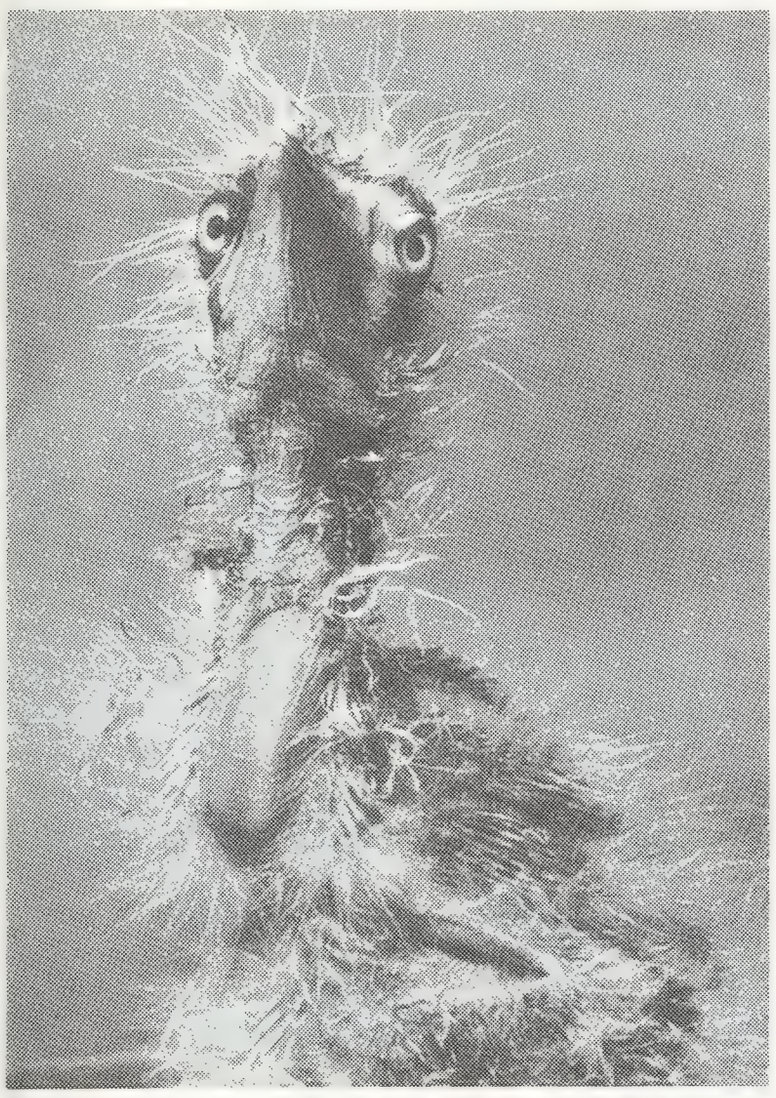
Often called the most beautiful of the cats, the snow leopard is soft gray in color, shading to white on the belly, with black rosettes on the body and tail. The tail is long, perhaps as much as three feet in length, which is only slightly less than the combined length of the head and body alone. The heavy coat makes the animal appear larger than it is; 70 to 80 pounds is the usual weight.

Because of its remote habitat, the snow leopard remains the least known of the big cats. Its classification as one of the five roaring cats – the others being the lion, tiger, leopard, and jaguar – is based on anatomy, for no one is known to have ever heard a snow leopard roar.

Dr. George B. Schaller, research zoologist for the New York Zoological Society's Center for Field Biology and Conservation, is one of the few scientists to have studied the snow leopard in the wild. Before sighting one of these elusive animals, at an altitude of 11,000 feet in Pakistan's Chitral Gol reserve, Dr. Schaller spent one week seeing only tracks. Finally he set up bait to attract the snow leopard, but it took an additional two weeks before the animal approached. Dr. Schaller was then able to observe the female snow leopard and catch glimpses of her cub for several days before they moved on.

No one knows how many snow leopards are left in the wild, but they are considered rare enough to be included in the Red Data Book of endangered mammals. Although the mountainous habitat seems inaccessible, hunters have managed to penetrate the remotest valleys to shoot or to set snares for the animals. India and Pakistan prohibit the commercial export of snow leopard skins, but smugglers still manage to get the valuable pelts to the international fur market.

The latest census figures available show that in 1971 there were 98 snow leopards in 44 zoos, and that 31 cubs were born in captivity during the year. The first snow leopards bred at the Bronx Zoo were two males, born in 1966. One of the males from this first litter, Sherpa, is the father of the new cubs at the Zoo. The mother, Mitzi, was wild-caught and arrived in the Bronx in 1967.



NYZS photo

A newly-hatched tiger bittern may look a fright, but it grows up to be a handsome bird. This chick was the first of its species to be bred at the Bronx Zoo.

TIGER BITTERN HATCHES AT BRONX ZOO

The first tiger bittern ever to be hatched at the Bronx Zoo emerged from its shell on the afternoon of Friday, September 27, 1972, and lay sprawled like a damp washcloth, resting after a monumental struggle to become free of the chalky white eggshell. After drying, and re-awakening, it looked even worse – with a scrawny neck, bug-like eyes, and a "fright-wig" halo of hair-like feathers on the crown. Everyone was very pleased, however, for this was just what a normal tiger bittern chick should look like.

There had been some concern as this had not been a normal hatching; the new addition to the Zoo's tiger bittern family (weighing in at 32 grams) was hatched in an incubator. The breeding birds involved are a pair of Amazonian tiger bitterns, *Tigrisoma lineatum,* that had been added to the collection in 1967, while still in the fawn-brown, black-streaked plumage of juveniles. They have been on display at the Aquatic Birds Building ever since. Now adult, with bright chestnut heads and necks, they first began to show an interest in nesting early in 1972.

A nest of the type and dimensions generally used by other herons was constructed by bird keepers and anchored in a prominent position in the display. While this new homesite was readily adopted by the tiger bitterns, almost all of the eggs laid were found broken within hours. The Department of Ornithology decided, therefore, to take each egg as soon as it was discovered and attempt to hatch it by artificial incubation.

Of the eggs placed in the incubator, several were fertile, but only the one laid on August 29 has hatched thus far. Being hatched away from the nest, this bird had to be hand-reared. Tiger bitterns feed largerly on fish, and when they are rearing young, they regurgitate a portion of their partially-digested meal directly into the beak of the chicks. It says much for the devotion of the bird keeping staff that its members made daily collections of this foul-smelling, but nutritional (for a young tiger bittern), mess; the adult birds were forced to disgorge part of their ration after it had undergone digestive action for several hours. Fortunately this procedure was only necessary for the first few weeks, and the young bird is now taking pieces of fresh fish on its own.

– Joseph Bell

CORRECTION:
In the August 1972 issue of ANIMAL KINGDOM, the following publication information was inadvertently omitted from a book review on p. 32:

NO FURTHER RETREAT: The Fight to Save Florida.

By Raymond F. Dasmann. 244 pp. Macmillan Co., New York, 1971. $6.95.

CHILDREN'S DAY AT THE ZOO

Animals and music was the theme of a special program for the children of New York Zoological Society members held at the Bronx Zoo, September 5. Young participants were personally introduced to animals from the Children's Zoo, such as African pigmy goats, while their older brothers and sisters attended ecology workshops given by the Zoo's education department. The music, supplied by the New York Summer Festival Orchestra under the direction of Louis F. Simon, featured selections with animal themes, and included "The Birds" by Respighi, "Louisiana Story" by Virgil Thomson, and "Peter and the Wolf" by Prokofiev.

BABY PIGMY SPERM WHALE SUCCUMBS

A month-long vigil ended at the New York Aquarium at 1 AM, October 26, when the baby pigmy sperm whale that had captured the attention of the world with its fight for survival died quietly in its tank.

The baby, a female, and its mother had been found on a beach near Coney Island, September 25, and were taken to the Aquarium. The mother died the next morning, but the 53-inch-long baby lived and although force-fed, it gained weight, a hopeful sign, reaching a maximum weight of 120 pounds.

But no baby whale of this species had ever survived in captivity for so long, and without its mother, this youngster had little chance. The knowledge gained during this trial, however, may enable future whale stories to have happier endings.

WHALE BLOOD: A KEY TO HEALTH FOR WHALES AND MAN

What is the best way to treat a sick whale? How are whales kept healthy in captivity? When you have four whales on your hands – which is the situation at the New York Aquarium – preventive medicine is important. For this reason Dr. Emil P. Dolensek, veterinarian for the New York Zoological Society, conducts routine diagnostic procedures every three months on the Aquarium's four beluga, or white whales, and three white-sided dolphins.

Routine whale checkups, however, require quite a lot of work. Both large tanks (the main whale tank containing Blanchon and Frances, and the Polar Bay Pool that holds the performing Alex and Ethel) must be drained so that Dr. Dolensek and Aquarium personnel can literally catch a whale by its tail – blood samples for analysis are taken from the tail fluke.

While the water is down, Dr. Dolensek also vaccinates the animals against *erysipelas*, a bacterial infection to which only a few living species are susceptible, including whales, dolphins, men, pigs, and turkeys. At the same time, microbiology samples from the whale's blowhole are taken. Analysis of these scrapings can reveal abnormal bacteria that might infect the lungs.

Dr. Dolensek believes that the best way to gauge the health of a whale-sized animal is through analysis of its blood samples. The blood is studied in an auto-analyzer, which provides information on the function of the heart, liver, kidney, and endocrine systems. Complete blood counts are done at the Bronx Zoo animal hospital. Serology (medical study of the serum) is done at Lawrence Hospital in Bronxville, New York.

The amount of blood used is miniscule in relation to the size of the animal. The 1300-pound whale has seven per cent of its body weight as blood, or 70 quarts. Only about 20 to 30 cubic centimeters of blood are needed for analysis, and this amount includes blood samples that are used by Montefiore Hospital in New York City for immunity studies.

The Montefiore Hospital Blood Bank enters the picture because whale blood may carry the key that will unlock one of medicine's most baffling mysteries – the nature of autoimmune diseases. In such disorders, an individual begins to develop antibodies that destroy his own tissue and blood cells. Antibody production is stimulated by substances called antigens, and a major barrier to the understanding and effective treatment of autoimmune disorders has been the inability to isolate and identify the causative antigen-antibody systems.

Ordinarily, antibodies are identified by testing a blood sample against other specimens whose antigens are known. When scientists attempted to identify autoimmune antibodies by this technqiue, however, they found that most autoimmune antibodies reacted with every specimen cell, regardless of which antigens each cell carried.

Recently, however, it was discovered that one type of red blood cell does not react with any of these antibodies. This is a very rare type of blood, called Rh Null, known to exist in only about half a dozen individuals in the world. Rh Null provides Montefiore researchers with a new approach to the identification of autoimmune antibodies, but the technique requires a large supply of Rh Null cells, as scarce a commodity as could exist. The Montefiore scientists then discovered that all whales are Rh Null. And thus it is that the New York Aquarium's white whales are currently donating blood to the Montefiore Hospital Blood Bank, enabling researchers to continue investigations into autoimmune diseases, with thanks to Moby Dick.

Dr. Emil P. Dolensek, veterinarian for the New York Zoological Society, takes microbiology samples from the blowhole of one of the white whales at the New York Aquarium as part of a periodic health check-up.

NYZS photo

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"...when the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can be again."
– William Beebe
First curator of birds, Bronx Zoo

Vanishing Species

SIBERIAN TIGER
Panthera tigris altaica

All tigers belong to but one species, *Panthera tigris,* but taxonomists and others who concern themselves with such matters have divided it into several races or subspecies – just how many depends on with which cataloguer one agrees. In the case of the Siberian race, there is some dispute over whether the few tigers living in the mountains of the Sino-Korean border region belong to it or to a separate subspecies. Generally, however, all of the tigers living in the rugged territory from the Sino-Korean border north through eastern Manchuria and far eastern U.S.S.R. above Vladivostock are considered Siberians.

Unfortunately, all of the tigers living in this region probably number less than 250, or even 200, individuals, for the Siberian tiger slowly is fading out of existence in the wild. In fact, more zoo-bred Siberians probably exist today than are living in the wild.

Like the other races of tiger, the Siberian form once ranged over a vast area. It was found from its present range west to Lake Baikal, north to the upper Lena River region, and south through Mongolia, the forests of Manchuria, and northeastern China to Korea.

Today probably less than 40 tigers remain in the mountains of North Korea and the adjacent parts of China; possibly twice that number live in Manchuria, and more than 100 of the striped cats live in the region above Vladivostock, east of the Ussuri River border with China.

The latter region is the site of the Sikhote-Alin mountain range, which runs parallel to the coastline on the east and the Ussuri on the west. Several rivers flow out of these mountains into the Ussuri, and the tigers concentrate in the reed beds that fringe these rivers.

Two reserves have been established by Soviet authorities to protect the tigers in the latter region. It has been illegal to kill tigers in the Soviet Union since 1947, although a few Siberians are captured alive for zoo-breeding programs. Korea protects tigers, but not China, where, in fact, soldiers not many years ago killed scores of the big cats. For that matter, a few tigers have been killed in the U.S.S.R., with the need for self-defense given as a reason. Tensions between the Soviets and Chinese have not helped the tiger, for the troop buildup that has resulted is concentrated in the best portions of the tiger's range.

The Siberian tiger is the largest of all cats, sometimes reaching a length of 13 feet and a weight of up to 650 pounds. Its coat is heavier and much paler than the other races of tiger, and adult males have massive heads and shoulders.

The Siberian tiger preys chiefly on the wild boar and also on deer. The Soviets are attempting to maintain wild boar populations so that tigers will not prey on domestic stock.

The Siberian tiger has been victimized by both habitat destruction and hunting. The first major destruction of Siberian tiger populations in the Soviet Union occurred during the beginning decades of this century, when large numbers of settlers moved into the animal's range. The settlers cleared and burned vast stretches of forest for agriculture and killed the tiger's prey as well. The boar and deer were decimated further by an especially tough winter in 1914.

A low point for the Siberian tiger in the Soviet Union was reached shortly before the Second World War when large numbers of tigers were killed or captured. By 1940 only 30 wild Siberian tigers remained in the U.S.S.R., a dozen of which were in a national park in the Sikhote-Alin mountains. From there, however, tigers recolonized part of their original range.

Meanwhile, the tiger long had been hunted in China, largely due to beliefs in the medicinal power of its various parts. Its blood allegedly is an aphrodisiac, its heart the source of courage, and its bones good against rheumatism, not to mention that its long-haired pelt is much prized.

Recently the Siberian tiger population has not shown more than a gradual decline, but even a slight decrease in numbers is critical for a species whose population is so low. Whether the Siberian will be preserved in the wild is an open question; the tiger's habit of wandering over large areas of land works against its being safeguarded by national parks and preserves. Siberians have been bred successfully in many zoos, and perhaps this is the only bright spot in the future of the world's most magnificent cat.

–Edward R. Ricciuti

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